Natural Conditions Assessment for Low pH and Low Dissolved Oxygen, Dragon Swamp and Tributaries in Essex, King and Queen, Gloucester, and Middlesex Counties, Virginia

Submitted by
Virginia Department of Environmental Quality

September 2008

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Executive Summary

This report presents the assessment of whether low pH and dissolved oxygen (DO) in Dragon Swamp and tributaries are due to natural conditions or whether a Total Maximum Daily Load (TMDL) must be performed because of anthropogenic impacts. The Dragon Swamp and tributaries are located in Essex, King and Queen, Gloucester, and Middlesex Counties in the Chesapeake Bay Coastal Basin (USGS Hydrologic Unit Code 02080102). The waterbodies identification codes (WBID, Virginia Hydrologic Unit) for the Dragon Swamp and tributaries are VAP-C02R, VAP-C03R and VAP-C03E. There are 197.07 total stream miles in the Dragon Swamp and tributaries watershed (National Hydrography Dataset (NHD)). A total of 51.92 miles of these tributaries were listed as impaired due to violations in water quality standards for pH or dissolved oxygen. This report addresses both the pH and dissolved oxygen impairments.

The drainage area of the Dragon Swamp and its tributaries is approximately 133.73 square miles. The average annual rainfall is 45.94 inches. The watershed is approximately 85,559 acres in size and is predominately forested (71.4 percent). Agriculture encompasses 18.8 percent of the watershed, with 10.4 percent cropland and 8.4 percent pasture/hayland. Urban areas comprise approximately 0.2 percent of the land base, and transitional areas total 1.0 percent of the watershed. Wetlands and open water comprise 8.6 percent of the watershed.

The Dragon Swamp and tributaries were listed as impaired on Virginia's 2002 303(d) Total Maximum Daily Load Priority List and Report, the 2002, 2004, 2006 and 2008 305(b) / 303(d) Integrated Report (VADEQ, 2002, 2004, 2006 & 2008) due to violations of the State's water quality standard for DO and pH. This report evaluates both the DO and pH impairments by determining if natural conditions are the cause of the impairment, thus obviating the need for a TMDL.

There were a total of 113 DO and 114 pH data points taken by DEQ at station 7-DRN010.48 from April 1994 through March 2008 (Figure E1). The DO standard violation rate was 11/113 (9.7%), and pH violations were 13/114 (11.4%). Similar time series data are presented for all stations on the Dragon Swamp and tributaries evaluated in this report. The station with the worst DO violation rate was 7-DGN003.76 with a rate of 12/22 (54.5%) (Figure E2).

Figure E1. pH concentrations (station 7-DRN010.48), April 1995 through March 2008.

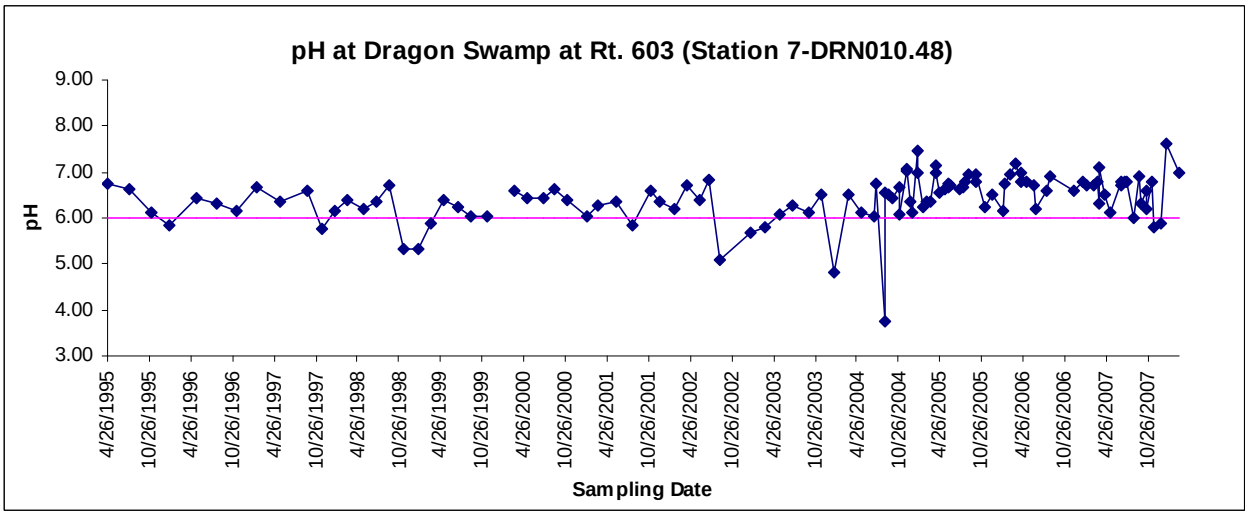
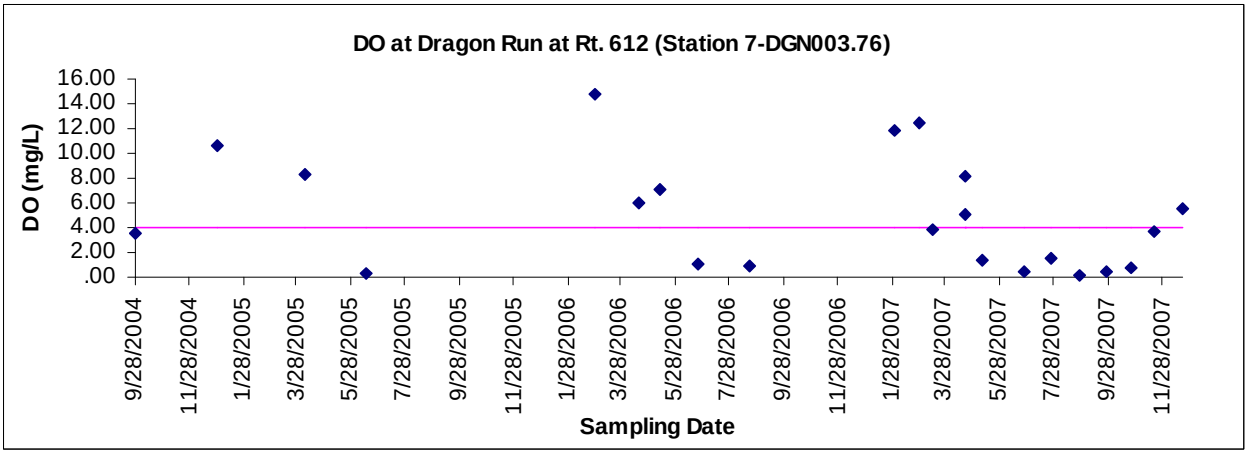


Figure E2. DO concentrations (station 7-DGN003.76), September 2004 through December 2007.



According to Virginia Water Quality Standards (9 VAC 25-260-10A), "all state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish)."

As indicated above, the Dragon Swamp tributaries must support all designated uses and meet all applicable criteria. If the waterbody violates the instantaneous DO water quality standard of 4.0 mg/l or pH values are less than 6.0 or greater than 9.0 in more than 10.5 percent of samples, the waterbody is classified as impaired and natural conditions must be determined or a TMDL must be developed and implemented to bring the waterbody into compliance with the water quality criterion.

In 2003 VADEQ proposed a methodology for determining whether low DO or pH originates from natural or anthropogenic sources, adapted from "Methodology for Assessing Natural Dissolved Oxygen and pH Impairments: Application to the Appomattox River Watershed, Virginia" (MapTech 2003).

The level of dissolved oxygen in a water body is determined by a balance between oxygen-depleting processes (*e.g.*, decomposition and respiration) and oxygen restoring processes (*e.g.*, aeration and photosynthesis). Certain natural conditions promote a situation where oxygen-restoring processes are not sufficient to overcome the oxygen-depleting processes. Conditions that would typically be associated with naturally low DO include slow-moving, ripple-less waters where the bacterial decay of organic matter depletes DO at a faster rate than it can be replenished. Indicators of these conditions include low slope, the presence of swamps or wetlands. These conditions often also produce low pH due to organic acids (tannins, humic and fulvic substances) produced in the decay process. These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems.

The general approach to determine if DO and pH impairments in free-flowing streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or low pH levels and for determining the likelihood of anthropogenic impacts is described below. DEQ staff use this approach to implement State Water Control Law 9 VAC 25-260-55, Implementation Procedure for Dissolved Oxygen Criteria in Waters Naturally Low in Dissolved Oxygen.

Before implementing this procedure, all DO and pH data should be screened for flows less than the 7Q10. DO and pH data collected on days when flow was < 7Q10 should be eliminated from the data set and the violation rate recalculated accordingly.

Step 1. Determine slope and appearance (presence of wetlands).
Step 2. Determine nutrient levels and compare with USGS background concentrations.

Step 3. Determine degree of seasonal fluctuation (for DO only).
Step 4. Determine anthropogenic impacts from permitted dischargers and land use.

There was one DO water quality standard violation that was obtained at flows below 7Q10, therefore that sample was removed from the dataset and the statistics were recalculated at station 7-DRN003.40. The recalculated DO violation rate was at 10.8%.

The slopes were determined for Dragon Swamp and 11 tributaries. The low slope for these streams ranged from 0.07% to 0.29%, which was considered very low to low slope. Decomposition of the large inputs of decaying vegetation from areas of forested land with swamps and heavy tree canopy throughout the watershed increase oxygen demand, lower DO, result in production of weak organic acids, and lower pH as they decay. These are not considered anthropogenic impacts.

The Dragon Swamp tributaries exhibit low nutrient concentrations below national background levels in streams from undeveloped areas, which are not indicative of human impact.

The Dragon Swamp tributaries exhibit natural seasonal DO fluctuation due to the inverse relationship between water temperature and DO.

There are eight active permitted point source facilities in the Dragon Swamp and tributaries watersheds. None of the facilities violated their permit limits for DO or pH during January 2003 to August 2008. These facilities are not expected to significantly impact DO or pH.

The watershed is predominately forested (71.4 percent), with 8.3 percent wetlands and 0.3 open water. Agriculture makes up approximately 18.8 % of the watershed. Residential and high use industrial areas compose approximately 0.2 percent of the land base, an insignificant portion of the watershed. Land use was not considered to have significantly impacted the swampwater conditions of the Dragon Swamp and tributaries.

Based on the above information, a change in the water quality standards classification to Class VII Swampwater due to natural conditions, rather than a TMDL, is proposed for Dragon Swamp and tributaries located in waterbodies VAP-C02R, -C03R, and -C03E, a total of 178.62 non-tidal rivermiles and 1.11 tidal square miles. The specific waterbodies are listed below in Table E1. If there is a 305(b)/303(d) assessment prior to the reclassification, Dragon Swamp and these tributaries will be assessed as Category 4C, Impaired due to natural condition, no TMDL needed.

Unnamed tributaries to Dragon Swamp coded XDO and XDX were not proposed for Class VII designation because their water quality data exceeded neither the DO nor pH water quality standards in more than 10.5 percent of samples. Unnamed tributary to Dragon Swamp XAY was not proposed for Class VII designation because the slope (0.65%) exceeded the recommended Class VII slope threshold of 0.50%, and the monitoring station was located in the upstream intermittent portion of the tributary. Contrary Swamp was included in the Class VII proposal because its slope (0.25%) was well below the upper slope threshold of 0.50% for Class VII and it contains areas of forested land with swamps and heavy tree canopy throughout most of the watershed. DEQ staff selected perennial headwaters as the upstream boundaries of the proposed Class VII segments because above the perennial portions of the waterbodies, flow was intermittent and slopes frequently exceeded the 0.50% upper Class VII threshold.

Table E1. Class VII Swampwater designations for the Dragon Swamp and Tributaries.

Stream	Miles	Upstream Class VII Boundary	Downstream Class VII Boundary
Briery Swamp and tributaries	3.93	Perennial Headwaters	Confluence with Dragon Swamp
Timber Branch Sw and tributaries	8.74	Perennial Headwaters	Confluence with Dragon Swamp
Exol Swamp and tributaries	25.37	Perennial Headwaters	Confluence with Dragon Swamp
Holmes Swamp and tributaries	8.74	Perennial Headwaters	Confluence with Exol Swamp

Yorkers Swamp and tributaries	4.28	Perennial Headwaters	Confluence with Dragon Swamp
White Marsh and tributaries	2.56	Perennial Headwaters	Confluence with Dragon Swamp
Contrary Swamp	2.02	Perennial Headwaters	Confluence with Dragon Swamp
Dragon Run and tributaries	13.18	Perennial Headwaters	Confluence with Dragon Swamp
Dragon Swamp and tributaries to RM 4.60	109.80	Perennial Headwaters	Head of Tide at River Mile 4.60
Dragon Swamp Tidal	1.11mi^2	Head of Tide at River Mile 4.60	Confluence with Piankatank River

DEQ performed the assessment of the Dragon Swamp tributaries low DO and low pH natural condition in lieu of a TMDL. Therefore neither a TMDL Technical Advisory Committee (TAC) meeting nor a public meeting was involved. Public participation will occur during the next water quality standards triennial review process.

1. Introduction

Dragon Swamp and tributaries including twenty-one Unnamed Tributaries to Dragon Swamp, Briery Swamp, Church Swamp, Timber Branch Swamp, Exol Swamp, Holmes Swamp, Yorkers Swamp, White Marsh, Contrary Swamp, and Dragon Run, located within Essex, King and Queen, Gloucester, and Middlesex Counties, Virginia, are minor tributaries to the Chesapeake Bay Coastal Basin. Dragon Swamp and tributaries encompass approximately 197.07 rivermiles. Staff determined rivermiles from the USGS National Hydrography Dataset using GIS. Dragon Swamp and tributaries generally flow southeast from the headwaters of Dragon Run near Rt. 620 at Millers Tavern, VA to the confluence with the Piankatank River east of Glenns, VA. Dragon Swamp is tidally influenced from approximately river mile 4.60 downstream to the confluence with the Piankatank River (VADEQ, 2002). The watershed totals approximately 133.73 mi^2. There is a continuous flow gaging station on Dragon Swamp near Mascot, VA (USGS: 01669520), which has a drainage area of 109 mi^2.

2. Physical Settings

2.1. Listed Water Bodies

The mainstem of Dragon Swamp was listed as impaired on Virginia's 2002 303(d) Total Maximum Daily Load Priority List and Report, and the 2004, 2006, and 2008 305(b) / 303(d) Integrated Reports (VADEQ, 2002, 2004, 2006, and 2008) due to violations of the State's water quality standard for pH. The mainstem of Dragon Swamp was then listed due to violations of the State's water quality standard for pH and DO in the 2004, 2006 and 2008 305(b) / 303(d) Integrated Reports. Exol Swamp was listed as impaired on Virginia's 2006 Water Quality Assessment 305(b)/ 303(d) Integrated Report due to violations of the State's water quality standard for pH and DO. Dragon Run was listed as impaired on Virginia's 2008 Water Quality Assessment 305(b)/ 303(d) Integrated Report due to violations of the State's water quality standard for DO. This report evaluates both the DO and pH impairments by determining if natural conditions are the cause of the impairment, thus obviating the need for a TMDL. The waterbodies identification codes (WBID, Virginia Hydrologic Unit) for the non-tidal Dragon Swamp tributaries are VAP-C02R, and VAP-C03R. The tidal Dragon Swamp WBID code is VAP-C03E. Of the total 197.07 rivermiles in the Dragon Swamp basin, 51.92 rivermiles were listed as impaired due to violations in water quality standards for pH or dissolved oxygen. This report addresses both the pH and dissolved oxygen impairments.

2.2. Watershed

2.2.1. General Description

Dragon Swamp and tributaries flow southeast from the headwaters of Dragon Run at Rt. 620 at Millers Tavern, VA to the confluence of the Piankatank east of Glenns, VA. The total area of the watershed is approximately 133.73 square miles. There is a continuous flow gauging station on Dragon Swamp near Mascot, VA (USGS: 01669520), which has a drainage area of 109 mi^2. See Figure 1 for a map of the watershed including monitoring stations.

Figure 1. The Dragon Swamp and tributaries watershed map and associated monitoring stations.

2.2.2. Geology, Climate, Land Use

Geology and Soils

The impaired segments of the Dragon Swamp and tributaries are predominately within the Atlantic Coastal Plain physiographic region, though the headwaters of some tributaries are located within the lower Piedmont physiographic province. The Atlantic Coastal Plain is the easternmost of Virginia's physiographic provinces. The Atlantic Coastal Plain extends from New Jersey to Florida, and includes all of Virginia east of the Fall Line. The Fall Line is the easternmost extent of rocky river rapids, the point at which east-flowing rivers cross from the hard, igneous and metamorphic rocks of the Piedmont to the relatively soft, unconsolidated strata of the Coastal Plain. The Coastal Plain is underlain by layers of Cretaceous and younger clay, sand, and gravel

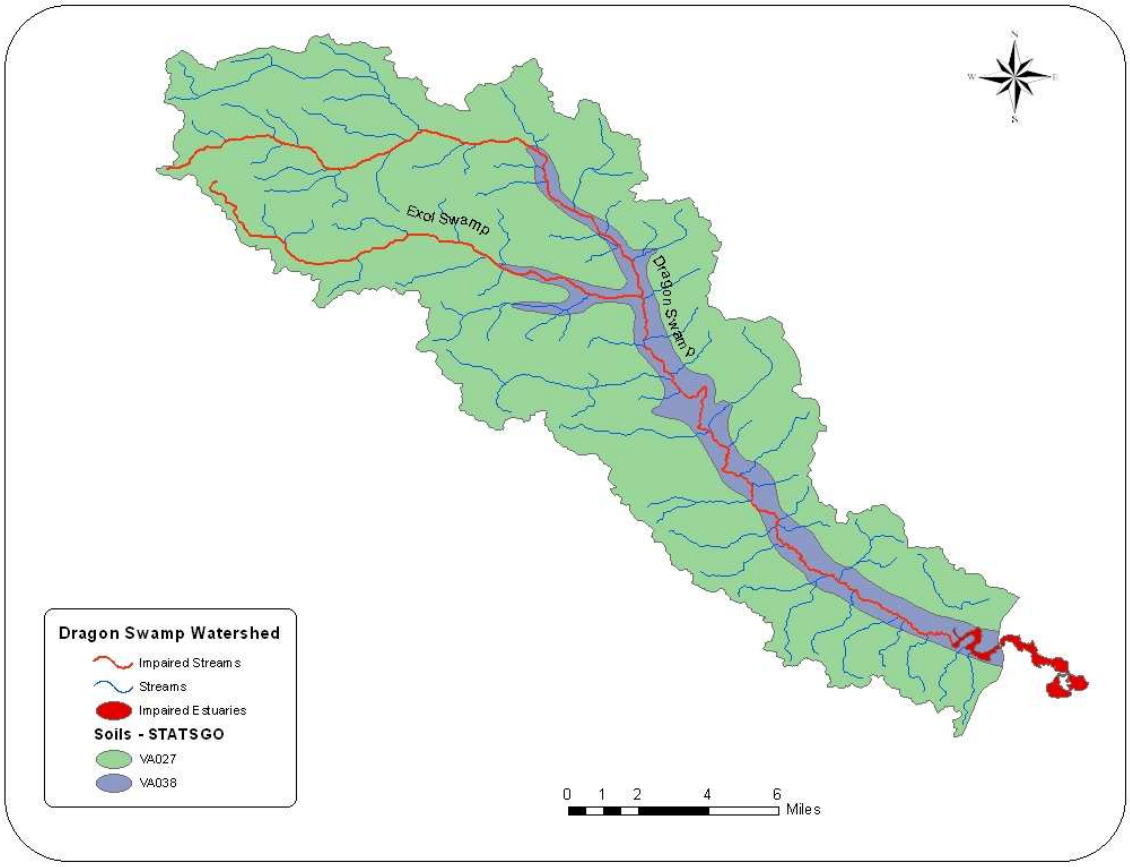
that dip gently eastward. These layers were deposited by rivers carrying sediment from the eroding Appalachian Mountains to the west. As the sea level rose and fell, fossiliferous marine deposits were interlayered with fluvial, estuarine, and beach strata. The youngest deposits of the Coastal Plain are sand, silt and mud presently being deposited in our bays and along our beaches (http://www.dcr.virginia.gov/natural_heritage/documents/overviewPhysiography_vegetation.pdf).

Soils for the Dragon Swamp watershed were documented utilizing the VA State Soil Geographic Database (STATSGO). Two general soil types were identified using in this database. Descriptions of these soil series were derived from queries to the USDA Natural Resources Conservation Service (NRCS) Official Soil Series Description web site (http://soils.usda.gov/technical/classification/osd/index.html). Figure 2 shows the location of these general soil types in the watershed.

Soils of the **Emporia-Johnston-Kenansville-Remlik-Rumford-Slagle-Suffolk-Tomotley (VA027)** series are very deep to deep, and vary between well drained to poorly drained with moderately slow or slow permeability. They formed in moderately fine-textured stratified fluvial and marine sediments on the upper Coastal Plain and stream terraces.

The **Pamunkey-Nansemond-Bibb-Kinston-Nawney-Bohicket Series (VA038)** are very deep, poorly to well drained soils, and range from well to moderately well to slow permeability. These soils are located on low stream or marine terraces and in the flood plains in the Piedmont and the Coastal Plain Physiograph Provinces. These soil series are formed in fine to coarse loamy marine and fluvial sediments and sandy alluvium.

Figure 2. Soil Characteristics of the Dragon Swamp Watershed.



Climate

The climate summary for the Dragon Swamp comes from a weather station located in Urbanna WB City, VA (448642) with a period of record from 1971 to 2000. The average annual maximum and minimum temperatures (°F) at the weather station are 68.4 and 49.7 and the annual rainfall (inches) is 45.94 (Table 1) (Southeast Regional Climate Center, http://www.sercc.com/climateinfo/historical/historical_va.html).

Table 1. Climate summary for Urbanna WB City, Virginia (448642).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	48.8	48.8	58.6	66.8	74.3	81.1	85.5	85.0	81.2	72.0	59.5	55.9	68.4
Average Min. Temperature (F)	30.5	29.3	38.3	43.8	54.9	65.0	68.9	68.1	63.9	53.5	40.5	37.5	49.7
Average Total Precipitation (in.)	2.39	3.73	3.29	3.29	5.35	5.39	4.12	3.81	4.00	4.07	2.97	3.52	45.94

Land Use

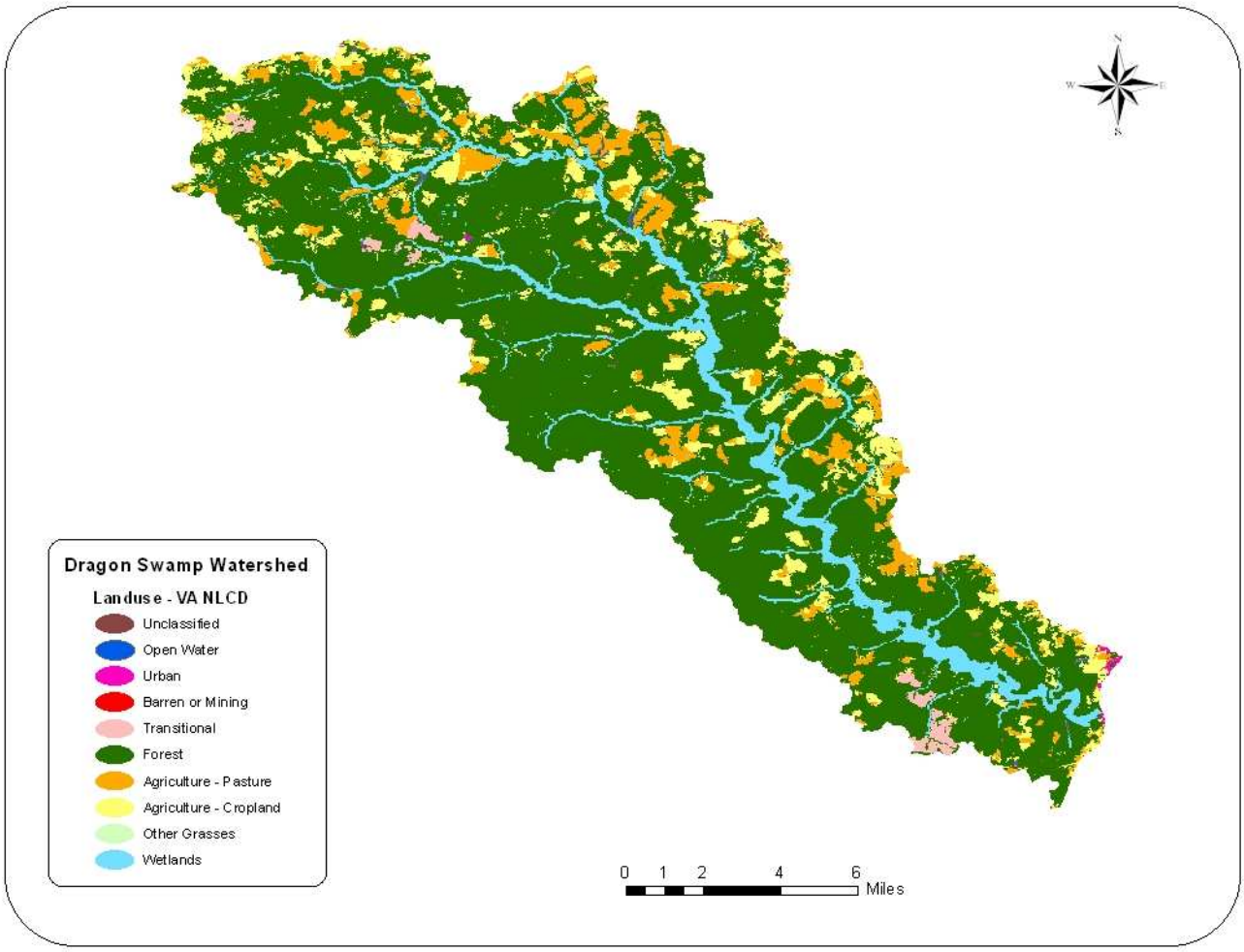
The Dragon Swamp and tributaries watershed extends approximately 22 miles from Millers Tavern to Glenns VA, and is 3 - 7 miles wide. The watershed is approximately 85559 acres (133.73 mi^2) in size and is predominately forested (71.4 percent). Agriculture comprises 18.8 percent of the watershed, with 10.4 percent cropland and 8.4 percent pasture/hayland. Urban areas compose approximately 0.2 percent of the land base. The remaining 1.0 percent of the watershed is comprised of transitional areas, and 8.6 percent wetlands and open water. Land use is described in Table 2.

A map of the distribution of land use in the watershed (Figure 3) shows that urban land use is concentrated near the mouth at the town of Saluda, and a small portion at the headwaters, and wetlands / water land use is concentrated along the mainstem in the center and downstream portions to the mouth.

Table 2. Land Use in the Dragon Swamp and Tributaries Watershed

Landuse	Acres	Sq Miles	Percent of Total
Open Water	217	0.34	0.3%
Urban	202	0.32	0.2%
Transitional	888	1.39	1.0%
Forest	61049	95.42	71.4%
Agriculture Pasture	7175	11.22	8.4%
Agriculture Cropland	8923	13.95	10.4%
Wetlands	7104	11.10	8.3%
Total:	85559	133.73	100.00%

Figure 3. Land Use in the Dragon Swamp and Tributaries Watershed



3. Description of Water Quality Problem/Impairment

The Dragon Swamp and tributaries were listed as impaired on Virginia's 2002 303(d) Total Maximum Daily Load Priority List and Report, 2004, 2006, and 2008 305(b) / 303(d) Integrated Report (VADEQ, 2002, 2004, 2006, and 2008) due to violations of the State's water quality standard for pH and DO. This report evaluates both the DO and pH impairments by determining if natural conditions are the cause of the impairment, thus obviating the need for a TMDL.

DEQ monitored 18 stations on Dragon Swamp and 10 tributaries (Figure 1) with dates ranging from September 1992 through May 2008. Of the 507 total pH data points recorded, 69 violated water quality standards for pH (13.6%), and 119 of 501 DO data points violated the water quality standards for DO concentration (23.8%). The DO minimum and maximum values ranged from 0.1 to 14.77 mg/L, and pH values ranged from 3.34 to 8.72. The results are summarized in Table 3.

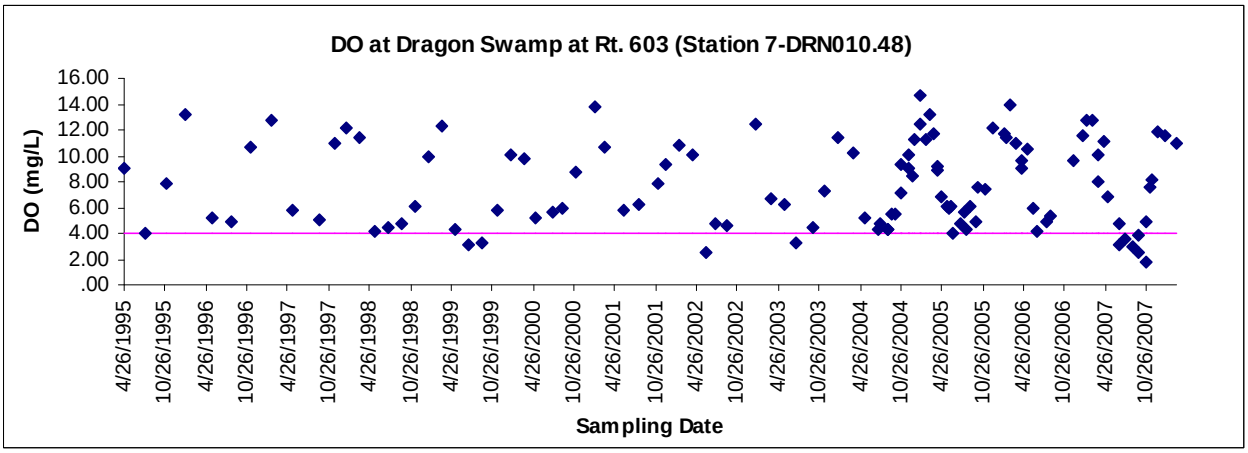
Table 3. DO and pH data collected by DEQ from 18 stations on Dragon Swamp and 10 tributaries.

		Number of Samples		mg/L		SU		Number of Violations	
Station	Sample Period	DO	pH	Average DO	Min-Max DO	Average pH	Min-Max pH	DO	pH
7-DGN000.85	9/28/2004 to 3/10/2008	29	30	6.3	.10-13.54	6.39	5.60-7.40	10	5
7-DGN003.76	9/28/2004 to 12/20/2007	22	22	4.91	.20-14.77	6.21	5.40-6.80	11	4
7-DRN003.40	9/28/1992 to 12/20/2007	75	75	7.57	.96-13.1	6.75	4.79-8.72	9	4
7-DRN010.48	4/26/1995 to 3/10/2008	113	114	7.73	1.8-14.61	6.43	3.75-7.6	11	13
7-DRN015.51	8/31/2004 to 12/20/2007	26	27	6.17	0.2-13.27	6.46	5.8-7.0	10	4
7-DRN024.19	6/6/2001 to 12/20/2007	34	34	6.08	0.1-14.0	6.09	3.34-7.02	15	11
7-DRN030.75	9/28/2004 to 12/20/2007	22	22	5.95	0.6-13.87	6.39	5.8-6.85	9	4
7-DRN032.57*	1/30/2007 to 12/20/2007	8*	8*	9.01	3.4-12.8	5.93	4.7-6.7	1	3
7-EXE000.81	7/16/2003 to 12/20/2007	35	35	6.35	0.3-13.51	6.4	4.84-7.5	10	4
7-EXE008.44	1/30/2007 to 12/20/2007	13	13	5.15	0.3-11.3	6.42	5.6-6.9	6	2
7-HLM000.81	3/15/2007 to 3/24/2008	12	12	7.37	3.1-11.9	6.52	5.9-7.1	2	2
7-TIM002.21	8/31/2004 to 12/20/2007	22	22	5.81	0.3-13.37	6.39	5.8-7.01	10	2
7-WHE000.96	1/30/2007 to 12/20/2007	12	12	5.61	0.8-11.6	6.02	5.5-6.6	6	6
7-XDO001.77	7/22/2004 to 12/20/2007	22	23	8.02	1.4-14.08	6.62	6.0-7.22	1	0
7-YOR001.42	1/30/2007 to 12/20/2007	12	12	7.3	3.8-11.8	6.19	5.6-6.9	1	4
7-XDX000.38	1/30/2007 to 12/20/2007	12	13	8.19	3.7-12.10	6.51	5.90-6.90	1	1
7-BRE002.50	8/31/2004 to 12/20/2007	22	23	6.87	.26-13.15	6.62	6.20-7.00	4	0
7-XAY001.64	7/22/2004 to 8/21/2006	10	10	7.19	2.5-13.1	6.77	6.3-7.6	2	0

* Dry from July – October 2007

A time series graphs of all data collected at the original listing station, Dragon Swamp at Rt. 603, 7-DRN010.48, shows the DO concentrations ranging from 1.80 mg/l to 14.61 mg/l (Figure 4). The horizontal line at the DO = 4.0 mark represents the minimum water quality standard. The data points below the DO = 4.0 line illustrate violations of the water quality standard.

Figure 4. Time series of DO at Dragon Swamp at Rt. 603, (station 7-DRN010.48).



3.1 Associated DO of Dragon Swamp Tributaries

DEQ also monitored and collected data at 17 stations from the mainstem Dragon Swamp and 10 tributaries for the assessment of low DO and pH due to the natural conditions. Associated stations with DO and pH data are presented in Figures 5-21, and 23-39 below.

Figure 5. DO Concentrations at Dragon Run at Rt. 607, 7-DGN000.85.

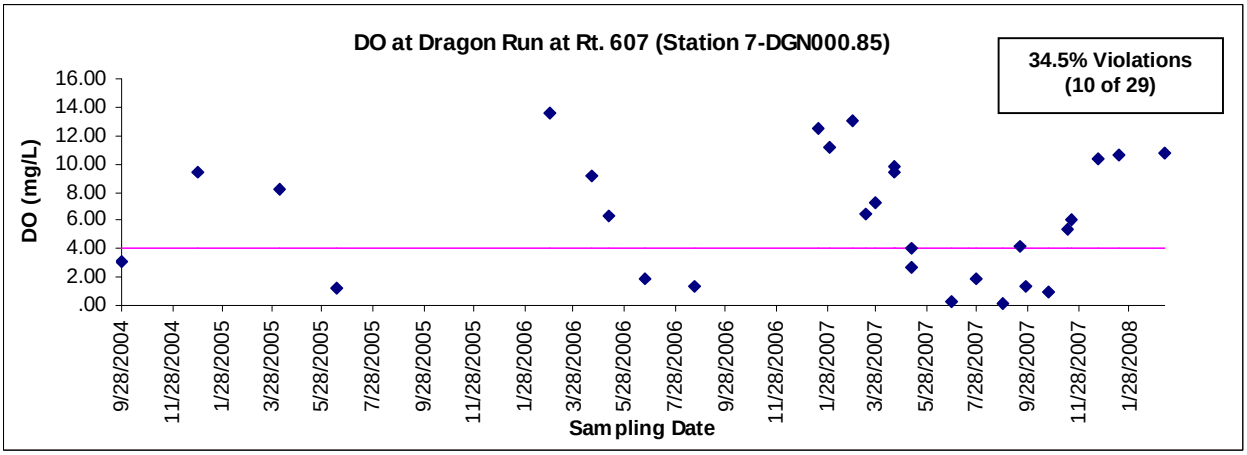


Figure 6. DO Concentrations at Dragon Run at Rt. 612, 7-DGN003.76.

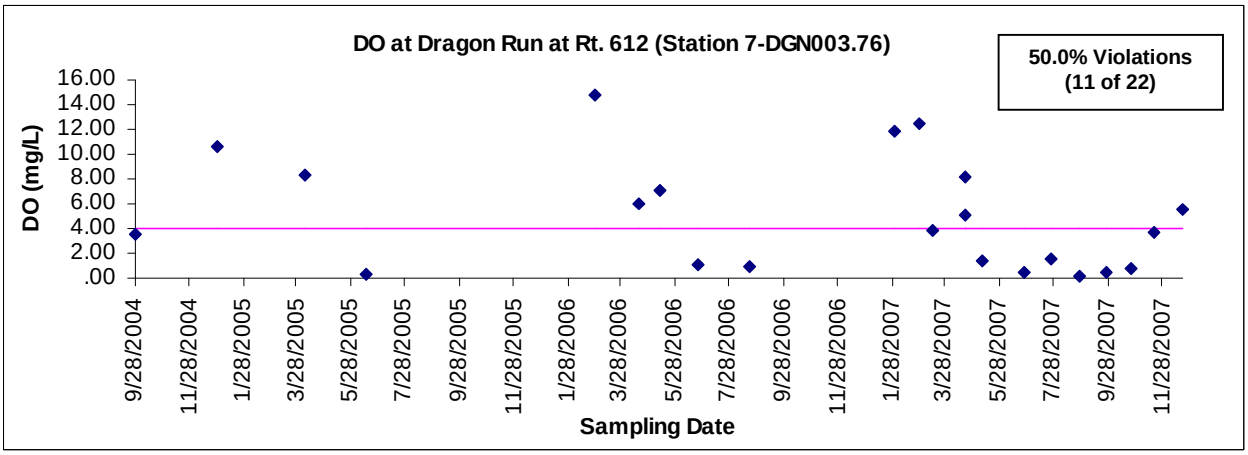
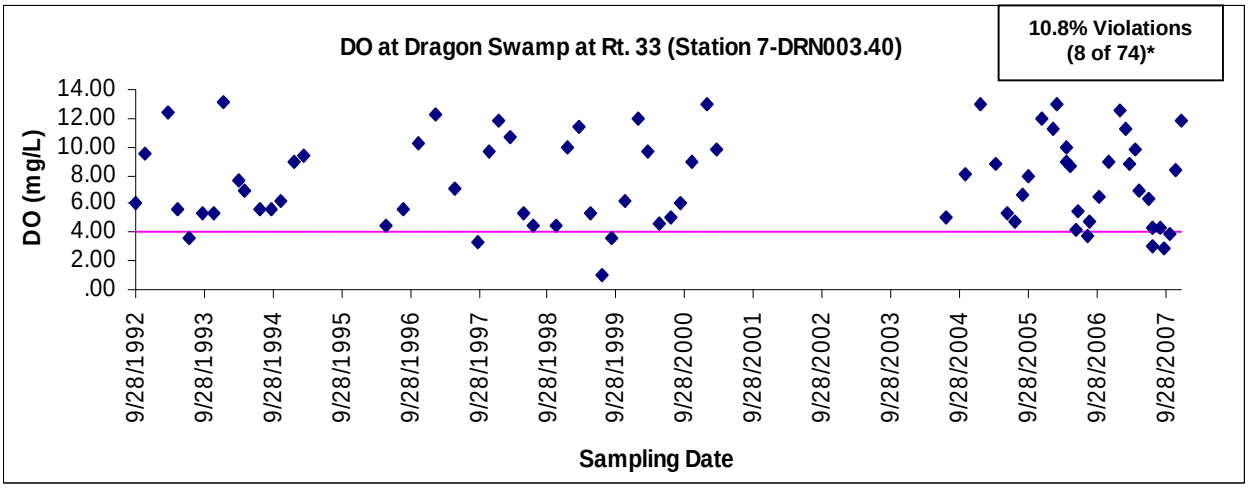


Figure 7. DO Concentrations at Dragon Swamp at Rt. 33, 7-DRN003.40.



*** - One violation removed, below 7Q10**

Figure 8. DO Concentrations at Dragon Swamp at Rt. 602, 7-DRN015.51.

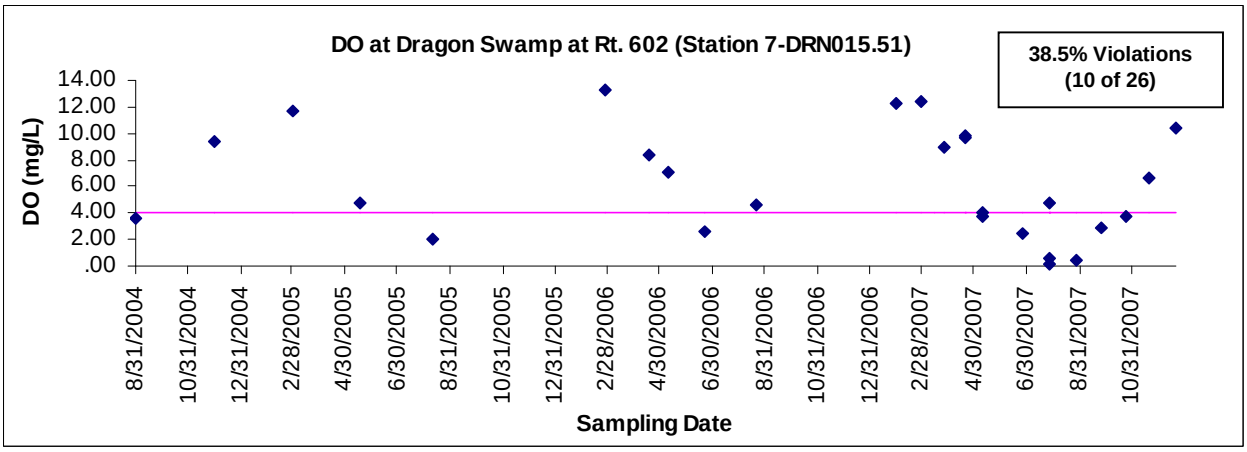


Figure 9. DO Concentrations at Dragon Swamp at Rt. 604, 7-DRN024.19.

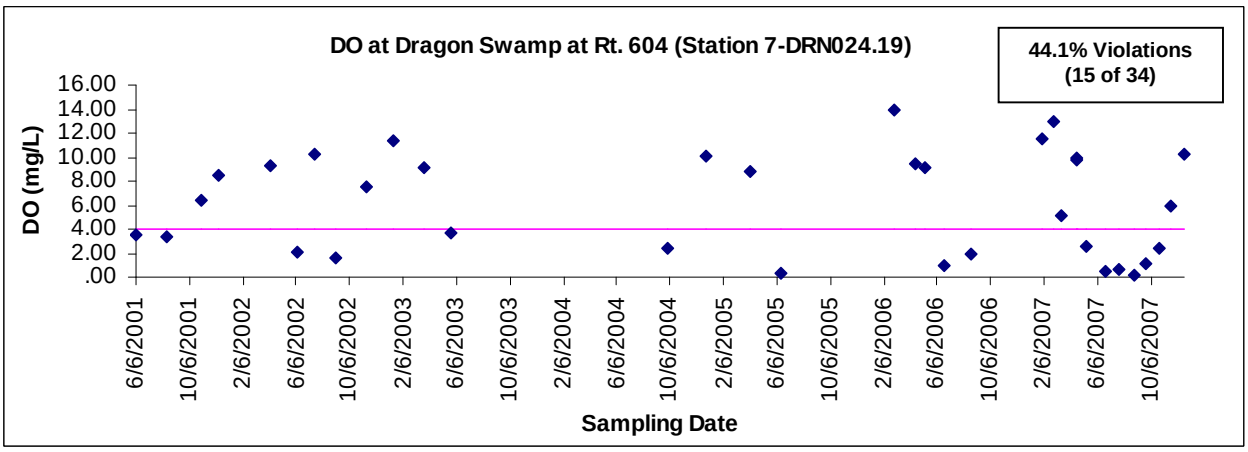


Figure 10. DO Concentrations at Dragon Swamp at Rt. 612, 7-DRN030.75.

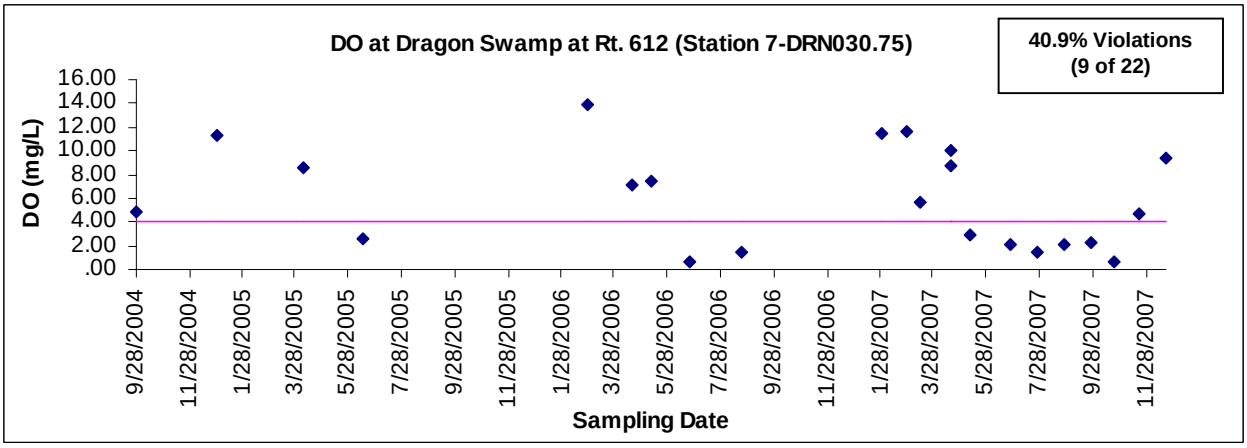


Figure 11. DO Concentrations at Dragon Swamp at Rt. 607, 7-DRN032.57.

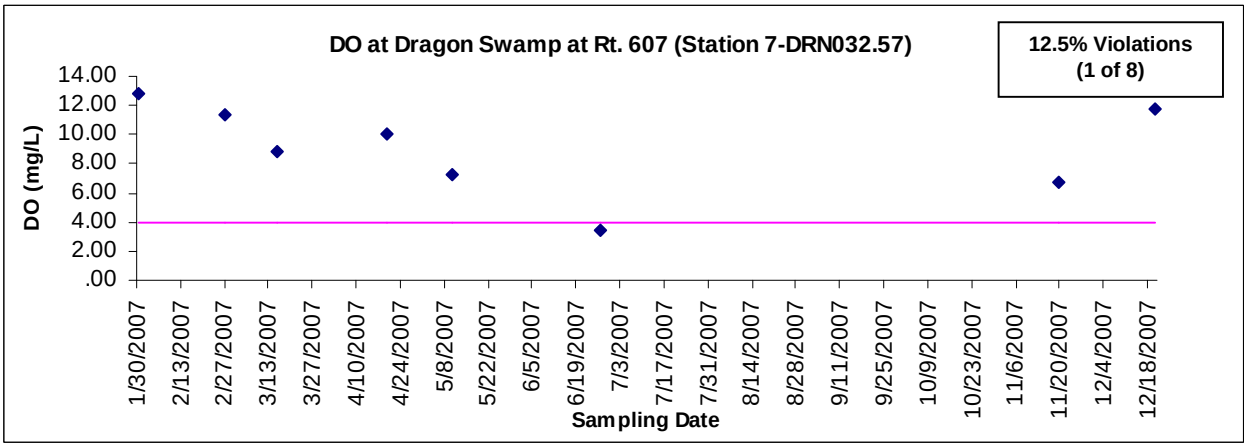


Figure 12. DO Concentrations at Exol Swamp at Rt. 614, 7-EXE000.81.

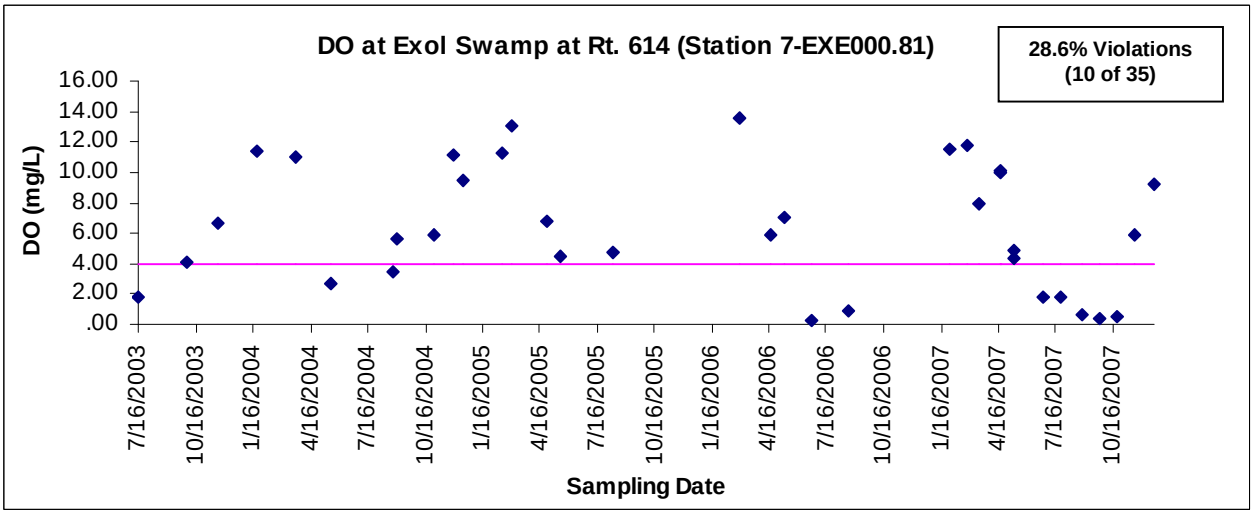


Figure 13. DO Concentrations at Exol Swamp at Rt. 612, 7-EXE008.44.

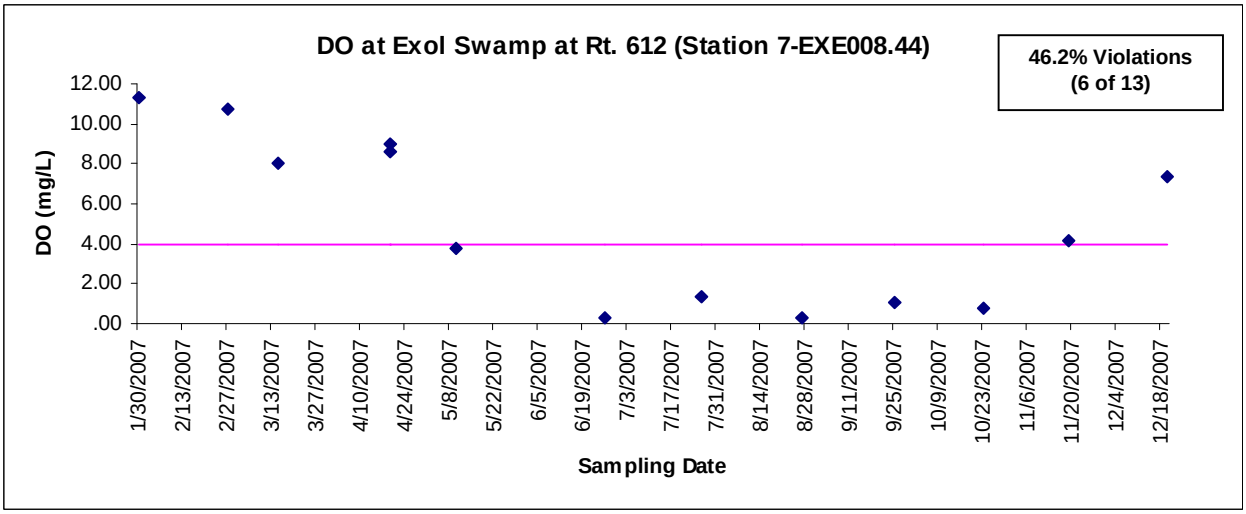


Figure 14. DO Concentrations at Holmes Swamp at Rt. 610, 7-HLM000.81.

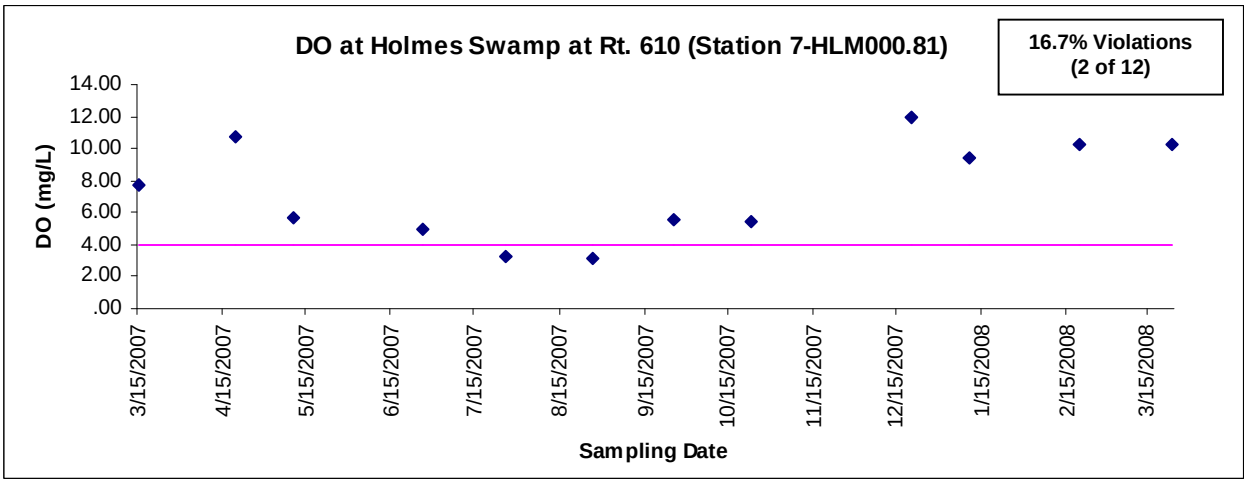


Figure 15. DO Concentrations at Timber Branch Swamp at Rt. 610, 7-TIM002.21

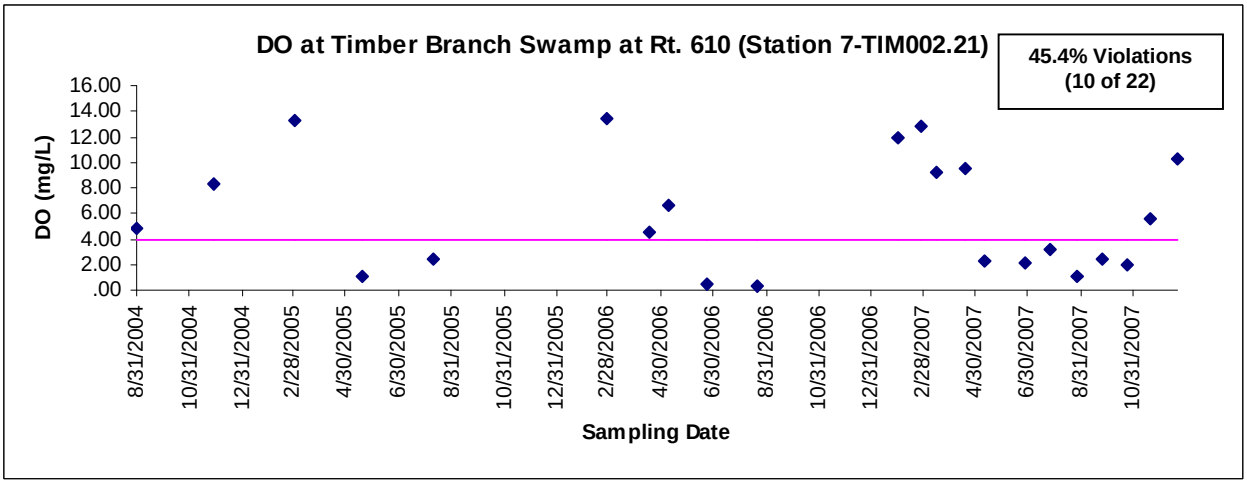


Figure 16. DO Concentrations at White Marsh at Rt. 684, 7-WHE000.96.

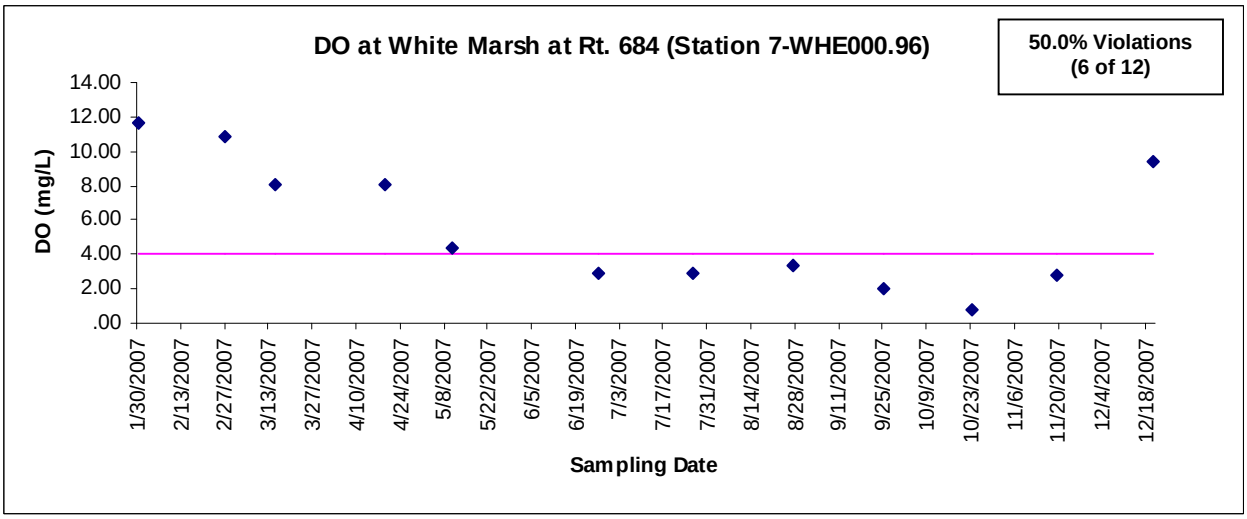


Figure 17. DO Concentrations at UT to Dragon Swamp at Piedmont Farm Rd, 7-XDO001.77.

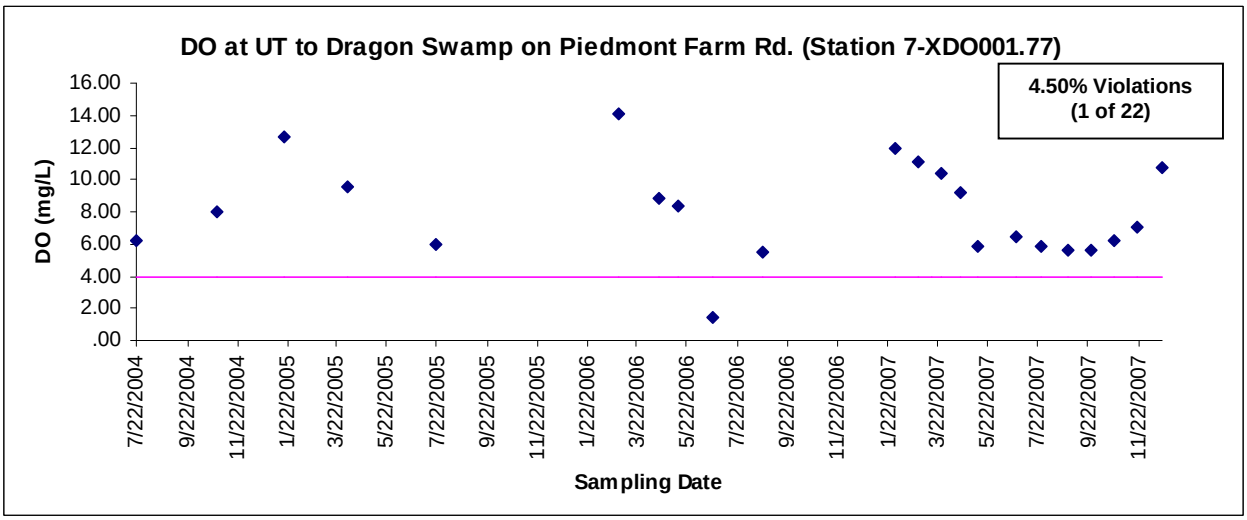


Figure 18. DO Concentrations at Yorkers Swamp East at Rt. 719, 7-YOR001.42.

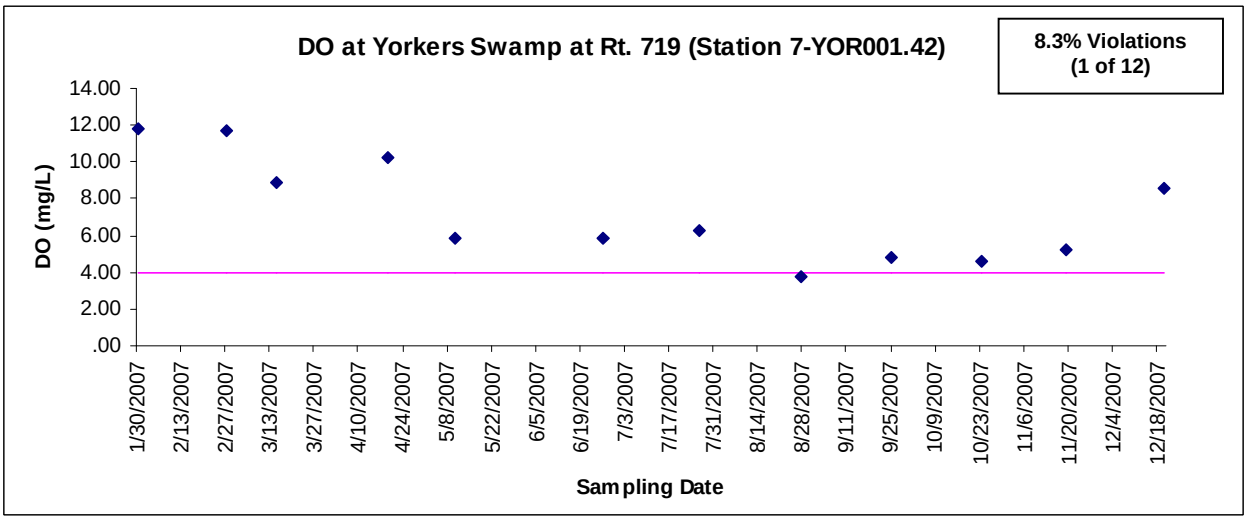


Figure 19. DO Concentrations at UT to Dragon Swamp at Rt. 610, 7-XDX000.38.

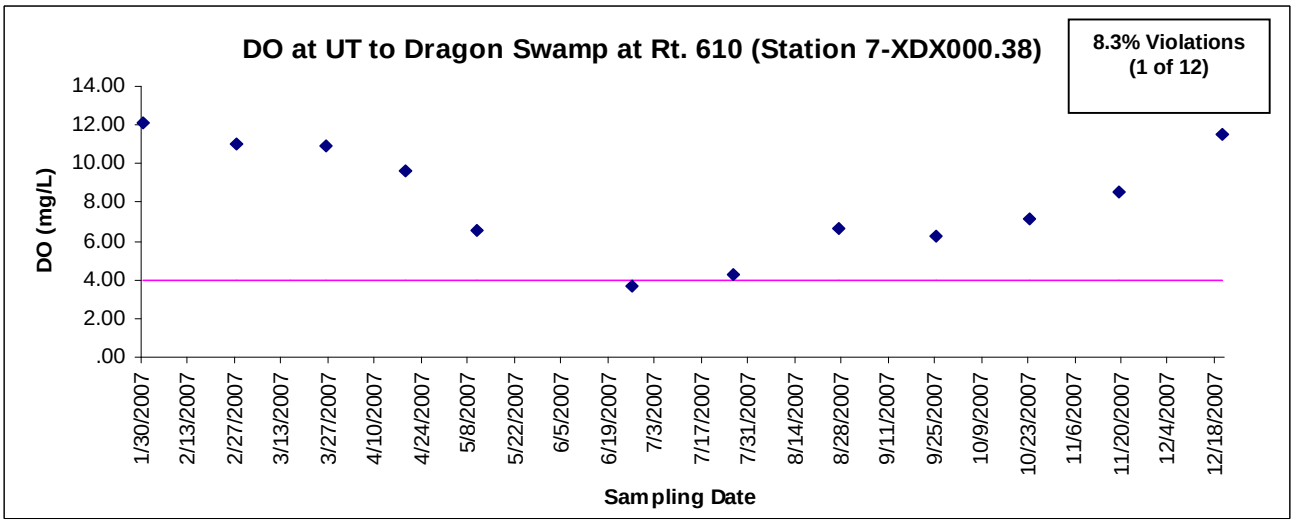


Figure 20. DO Concentrations at Briery Swamp at Rt. 606, 7-BRE002.50.

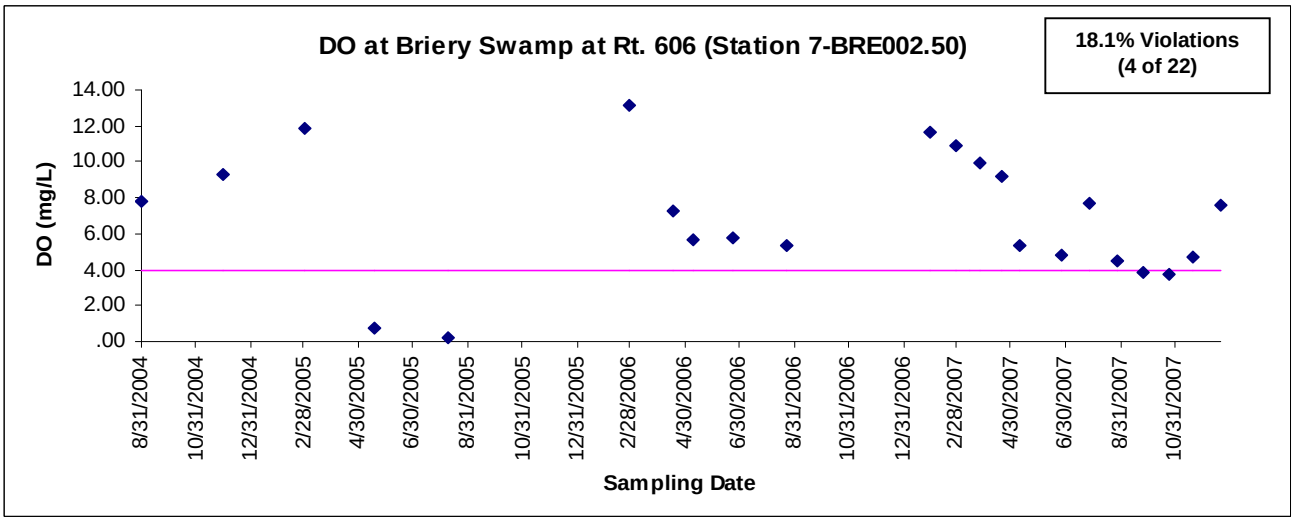
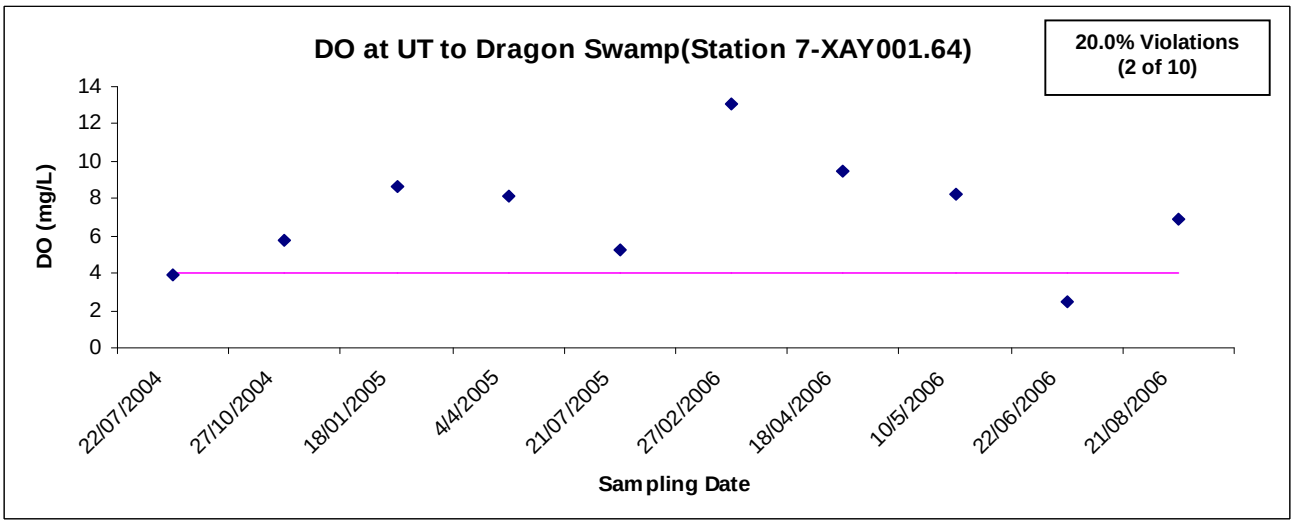
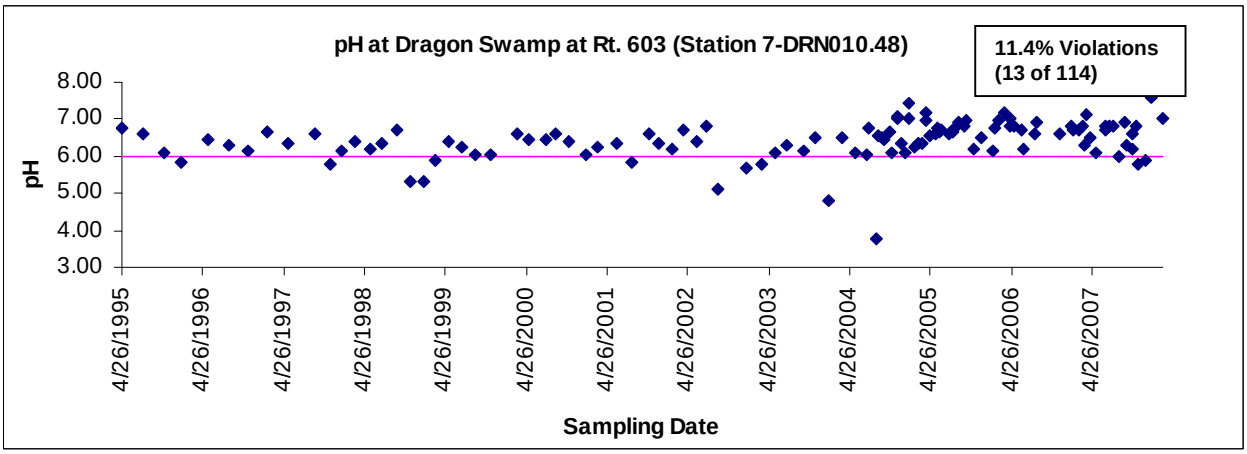


Figure 21. DO Concentrations at UT to Dragon Swamp, 7-XAY001.64.



A time series graphs of all data collected at the original listing station, Dragon Swamp at Rt. 603, 7-DRN010.48, shows the pH concentrations ranging from 3.75 SU to 7.60 SU (Figure 22). The horizontal line at the pH = 6.0 mark represents the minimum water quality standard. The data points below the pH = 6.0 line illustrate violations of the water quality standard.

Figure 22. Time Series of pH at Dragon Swamp at Rt. 603, (station 7-DRN010.48).



Figures of pH data at the 17 associated stations follow:

Figure 23. pH at Dragon Run at Rt. 607, 7-DGN000.85.

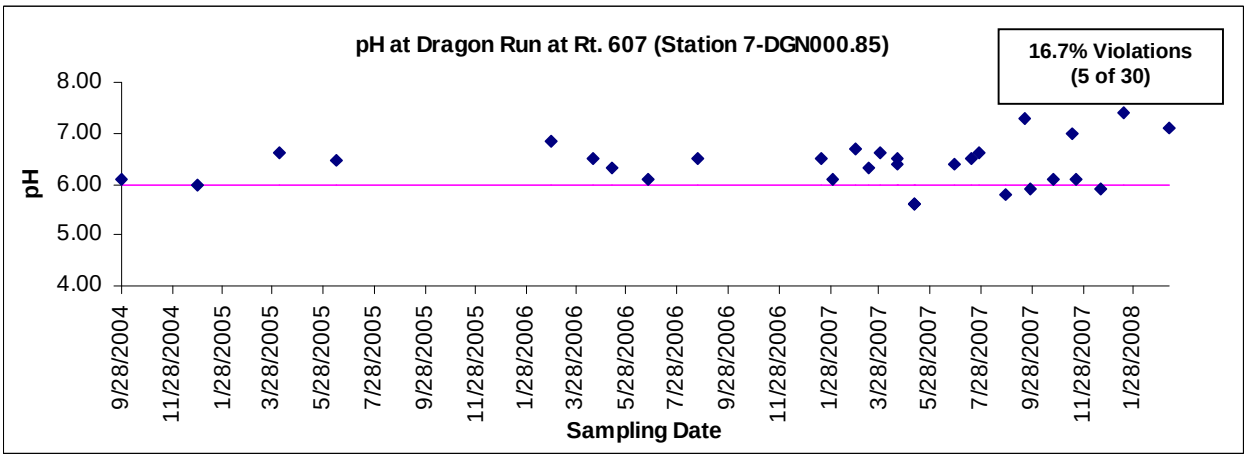


Figure 24. pH at Dragon Run at Rt. 612, 7-DGN003.76.

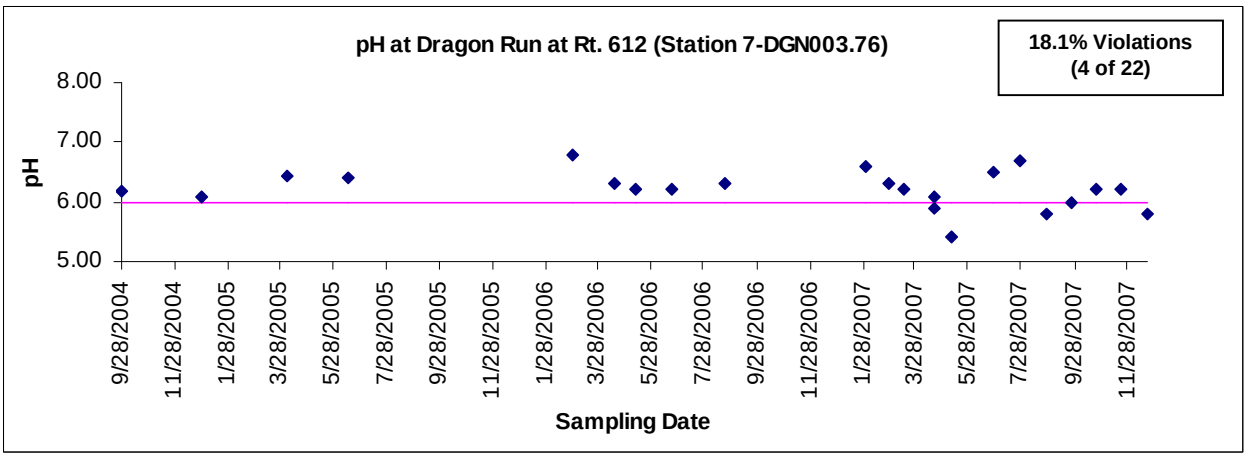


Figure 25. pH at Dragon Swamp at Rt. 33, 7-DRN003.40.

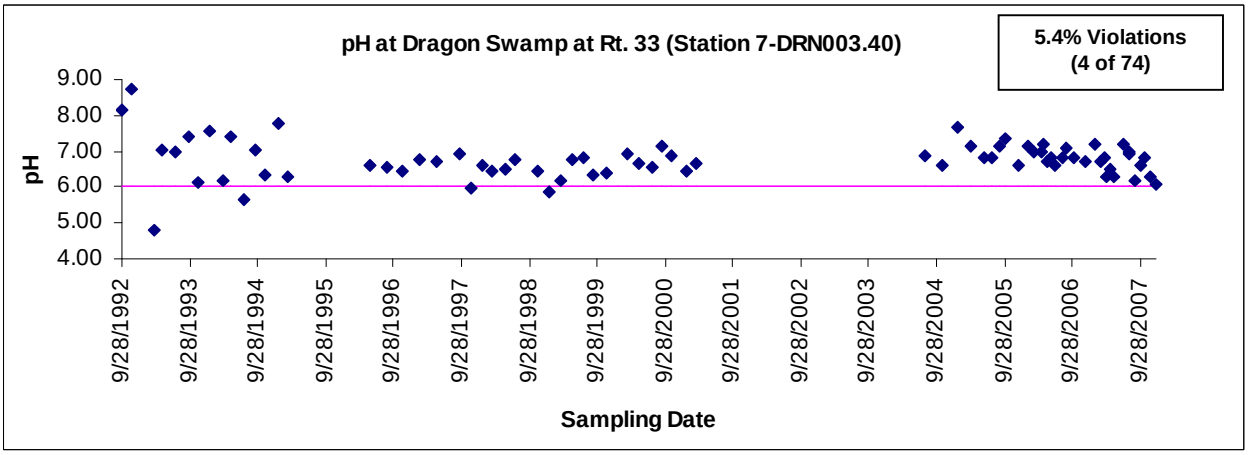


Figure 26. pH at Dragon Swamp at Rt. 602, 7-DRN015.51.

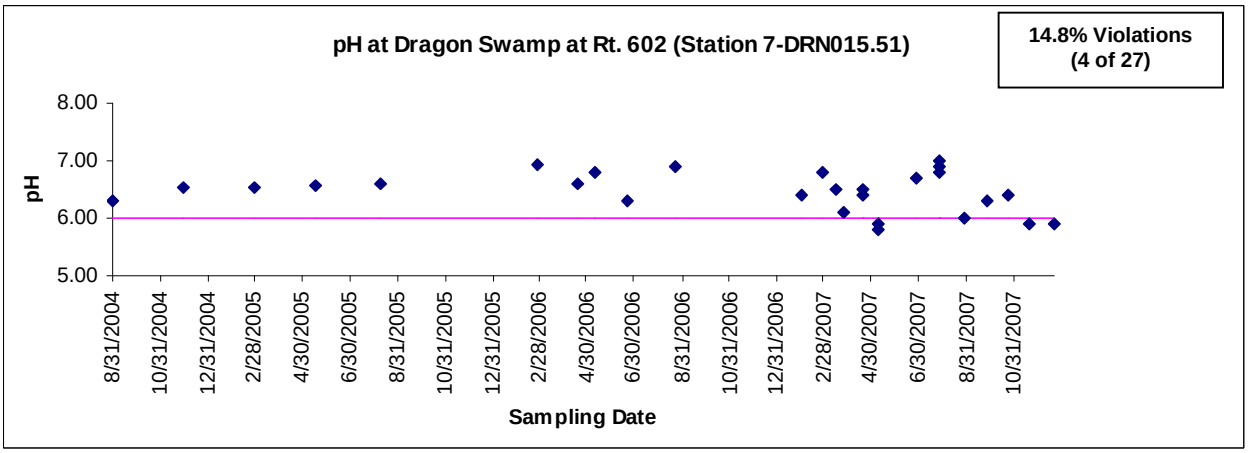


Figure 27. pH at Dragon Swamp at Rt. 604, 7-DRN024.19.

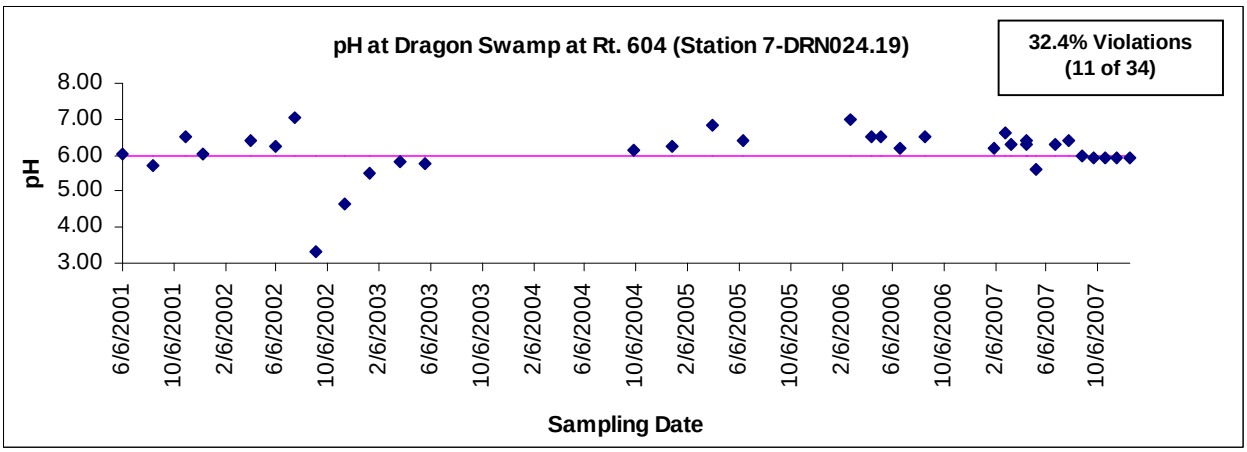


Figure 28. pH at Dragon Swamp at Rt. 612, 7-DRN030.75.

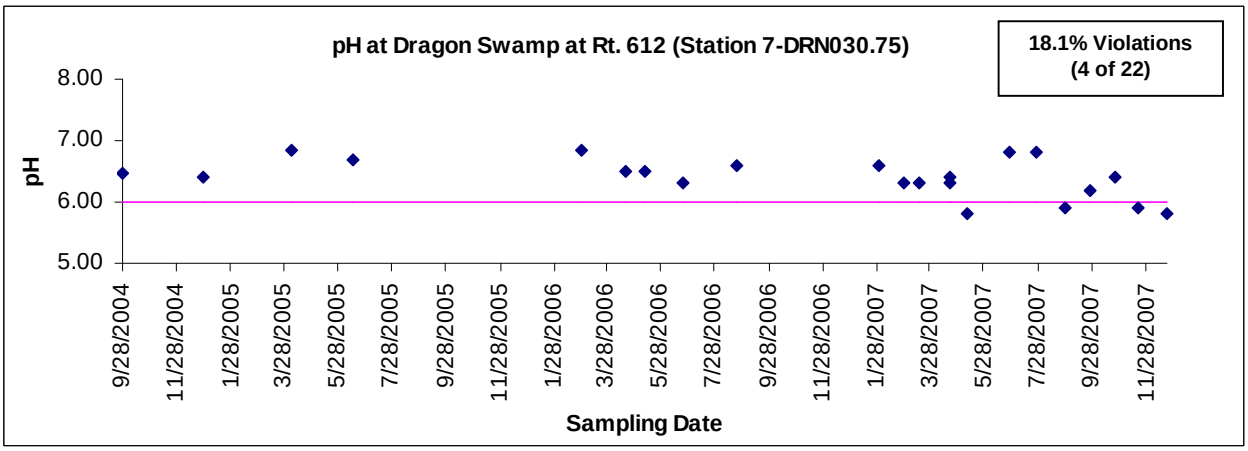


Figure 29. pH at Dragon Swamp at Rt. 607, 7-DRN032.57.

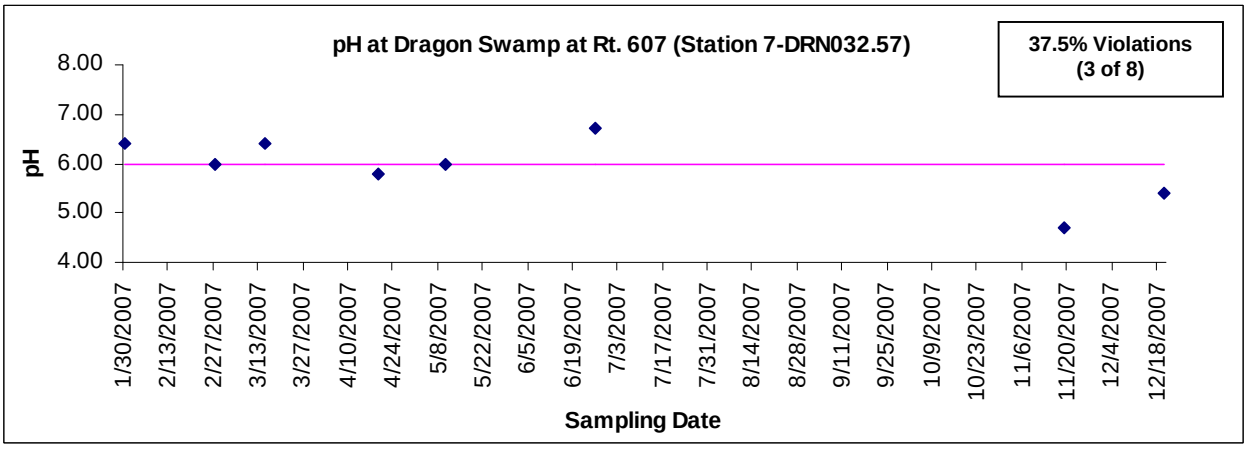


Figure 30. pH at Exol Swamp at Rt. 614, 7-EXE000.81.

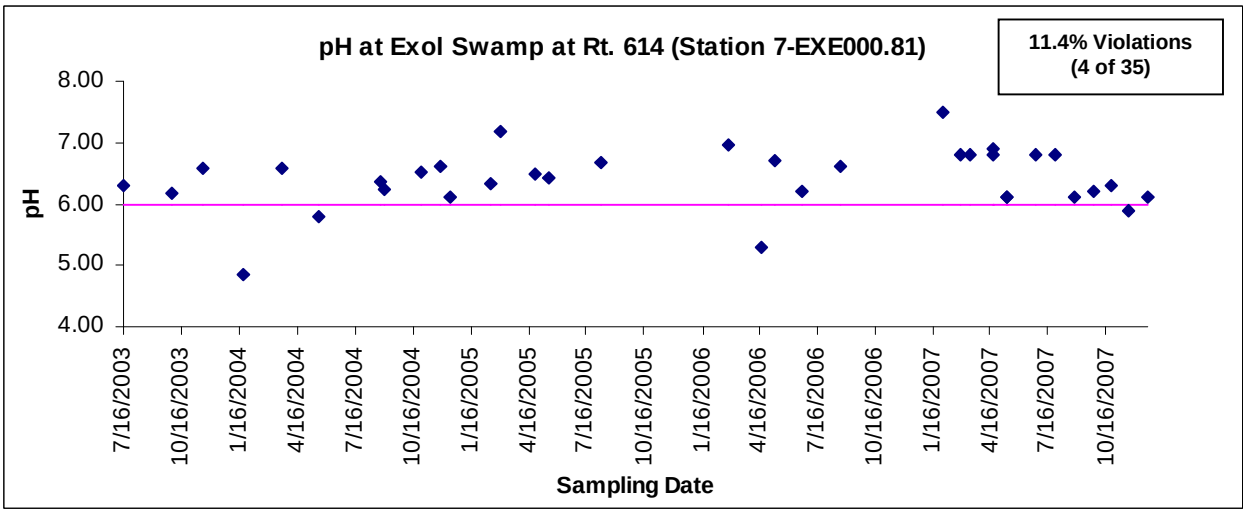


Figure 31. pH at Exol Swamp at Rt. 612, 7-EXE008.44.

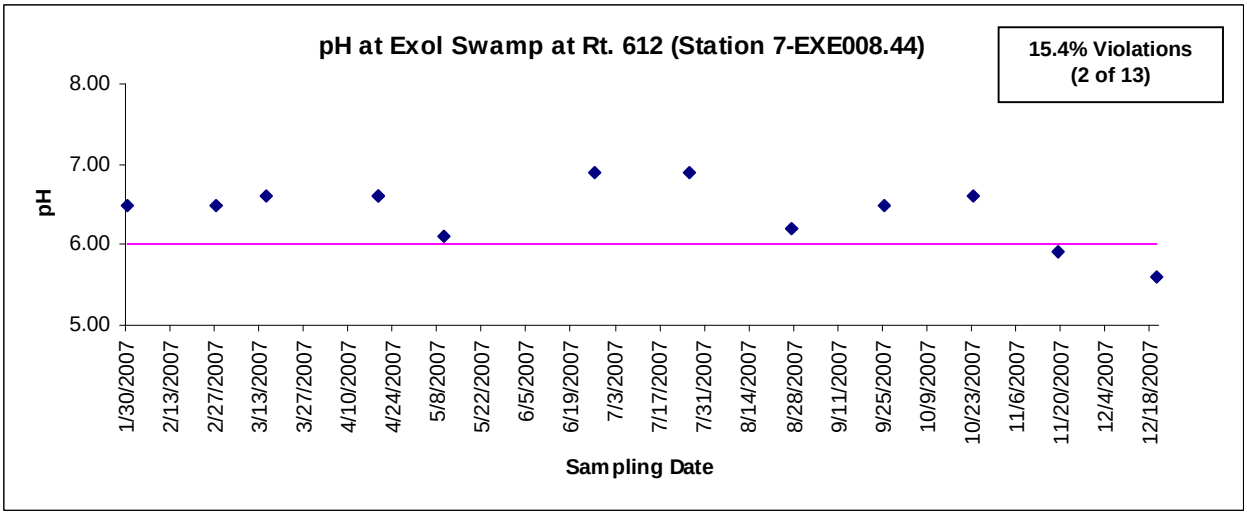


Figure 32. pH at Holmes Swamp at Rt. 610, 7-HLM000.81.

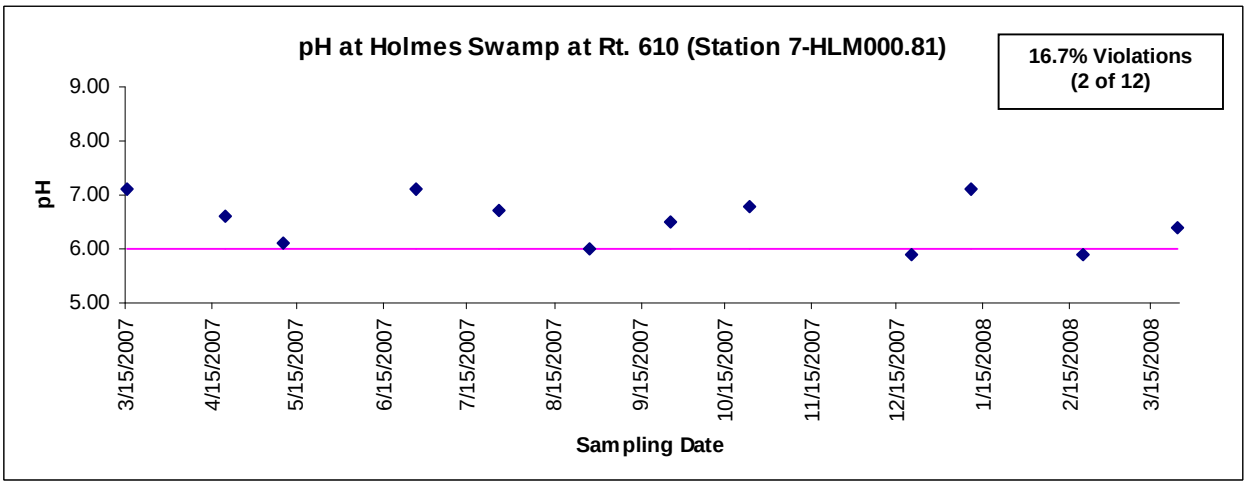


Figure 33. pH at Timber Branch Swamp at Rt. 610, 7-TIM002.21.

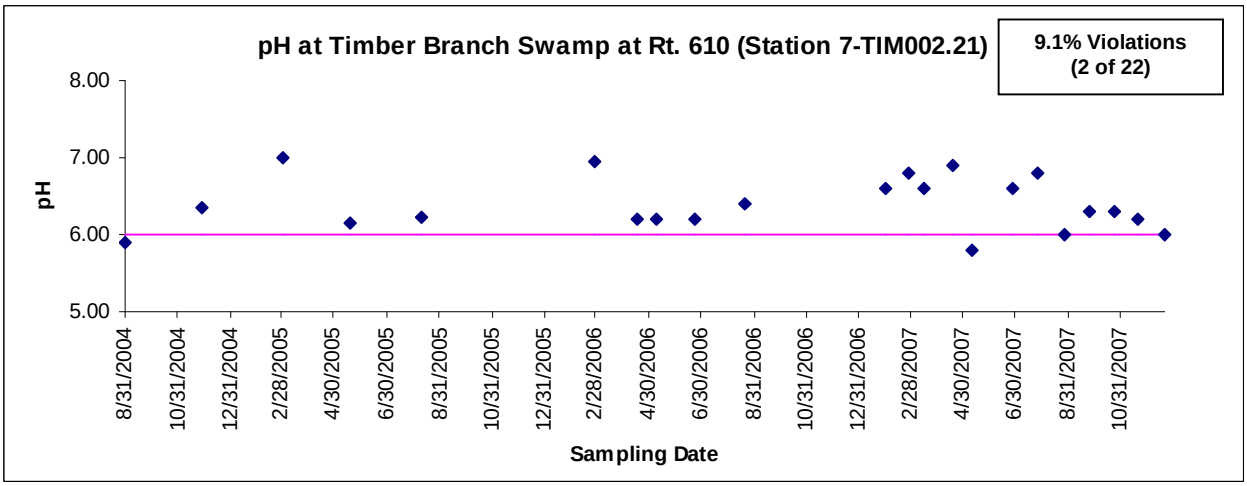


Figure 34. pH at White Marsh at Rt. 684, 7-WHE000.96.

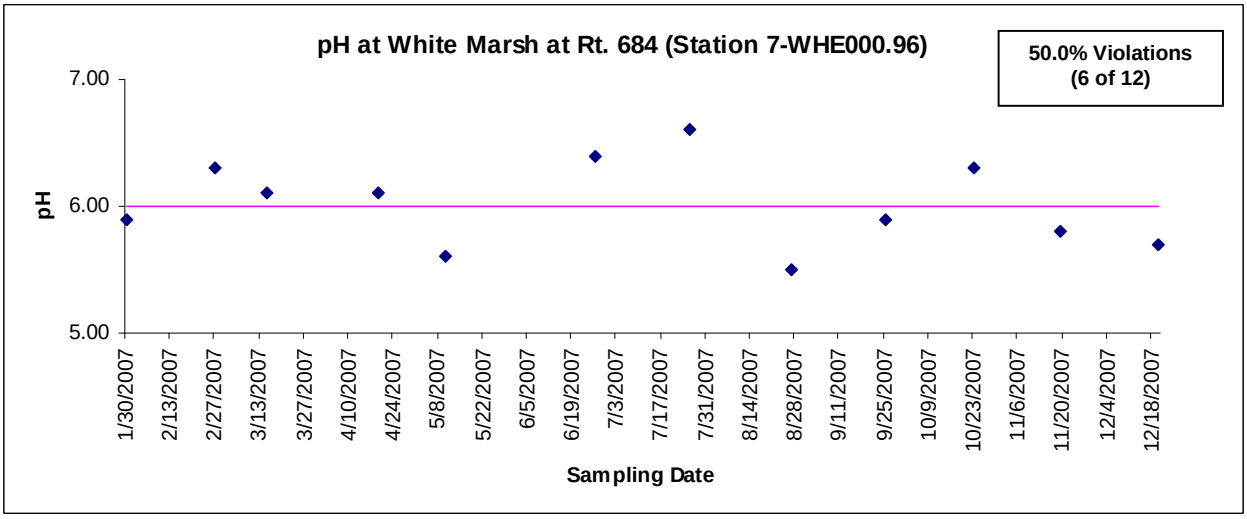


Figure 35. pH at UT to Dragon Swamp at Piedmont Farm Rd, 7-XDO001.77.

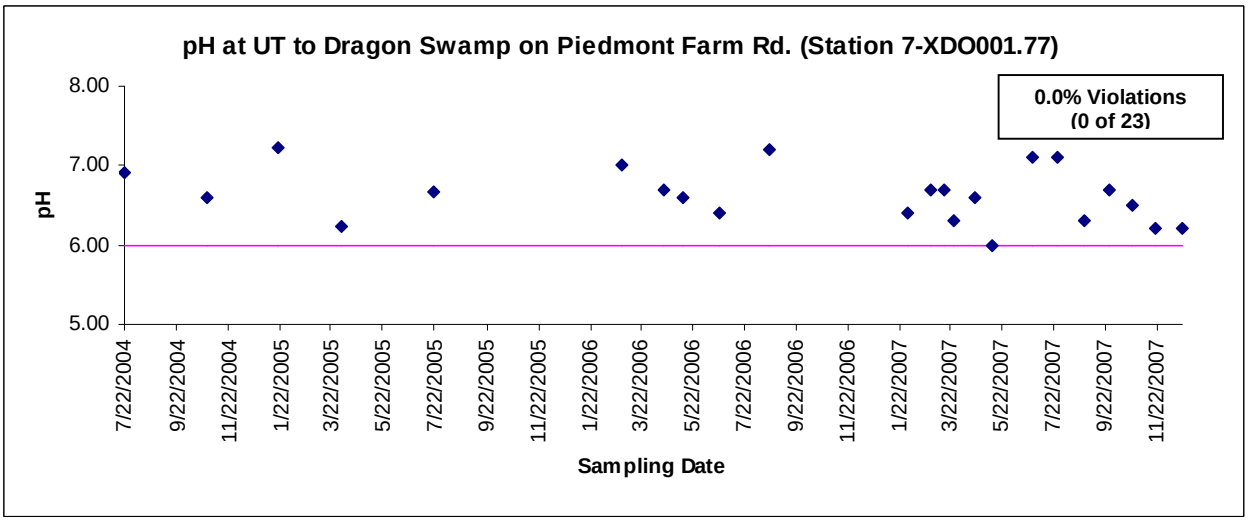


Figure 36. pH at Yorkers Swamp at Rt. 719, 7-YOR001.42.

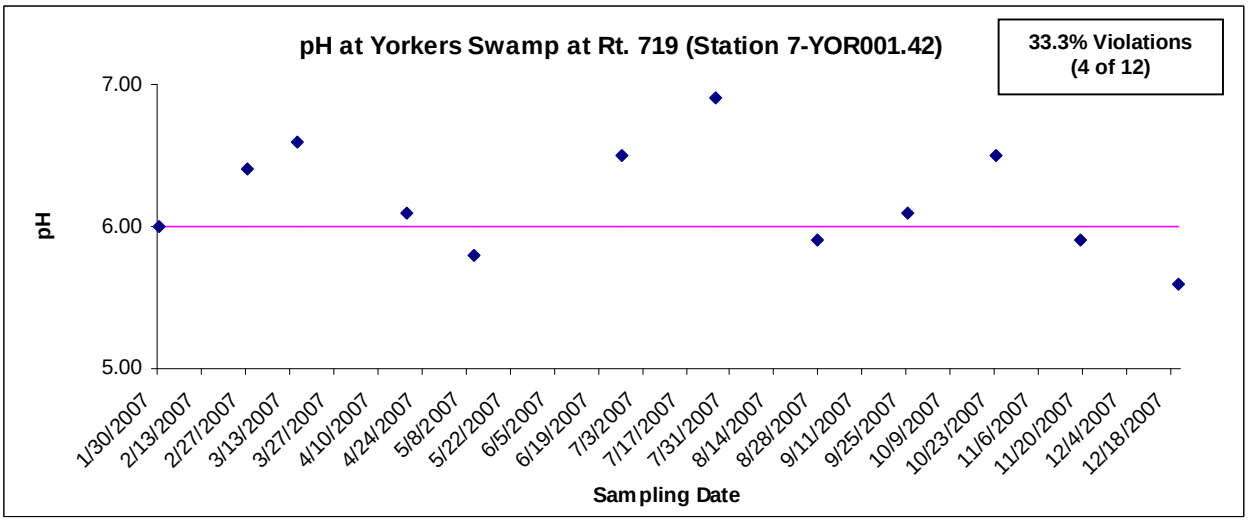


Figure 37. pH at UT to Dragon Swamp at Rt. 610, 7XDX000.38.

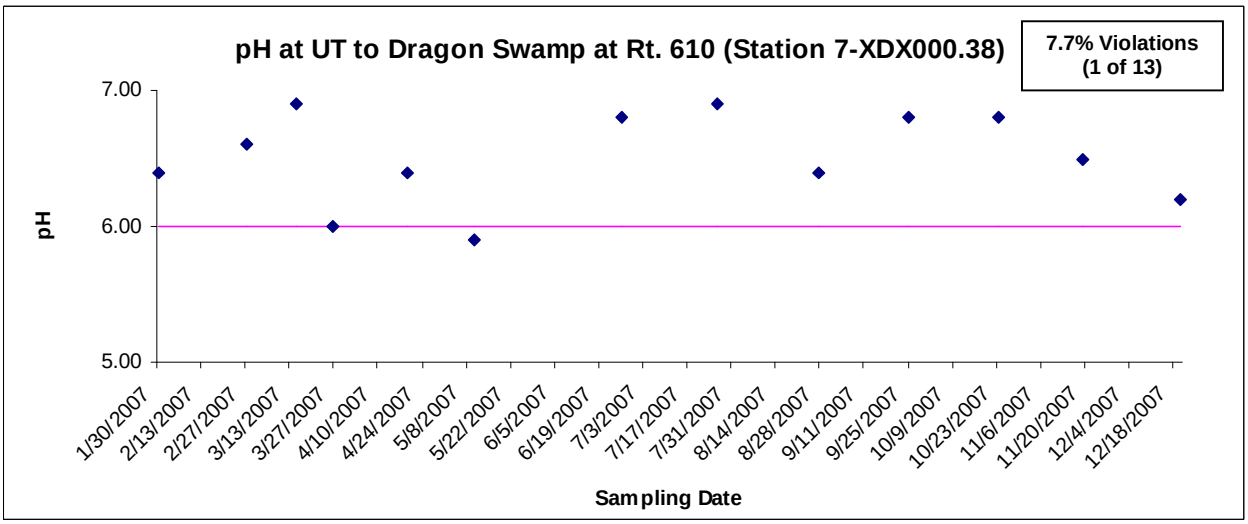


Figure 38. pH at Briery Swamp at Rt. 606, 7BRE002.50.

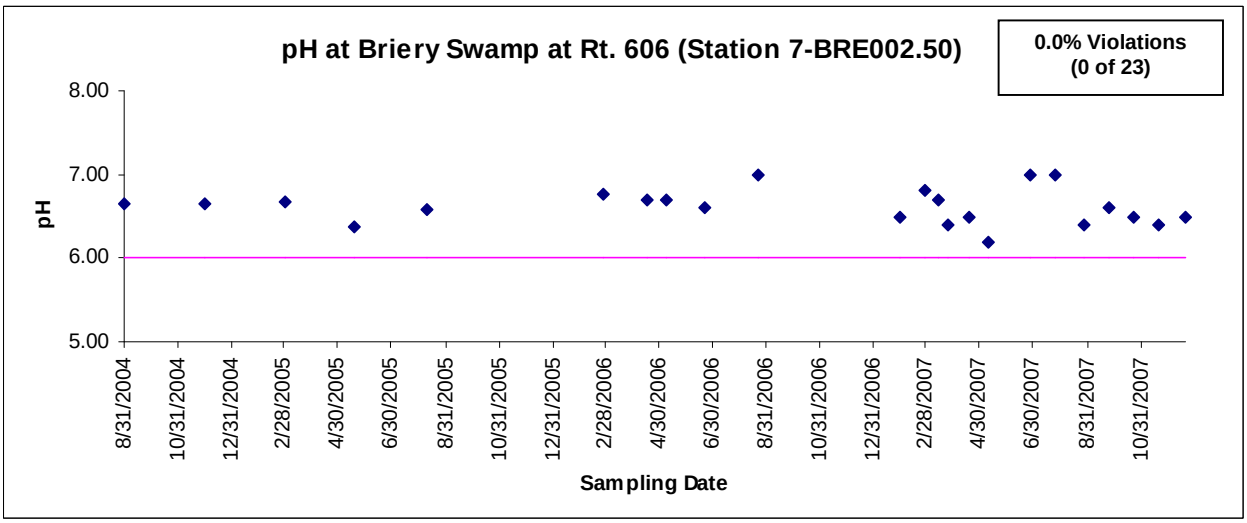
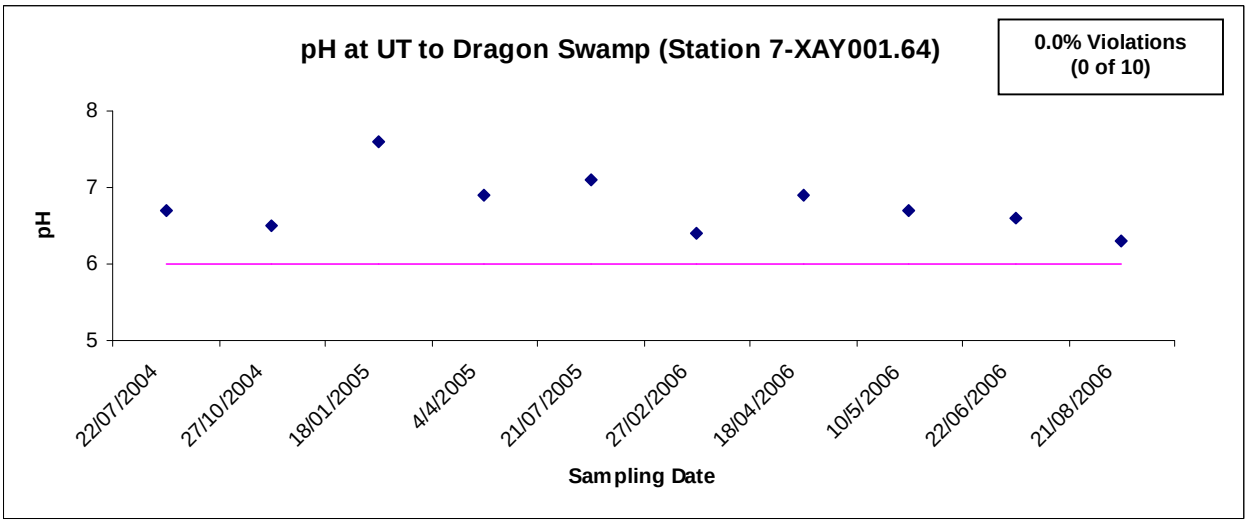


Figure 39. pH at UT to Dragon Swamp, 7-XAY001.64.



All stations monitored on Dragon Swamp, Dragon Run, Exol Swamp, Holmes Swamp and White Marsh exceeded the water quality standards for DO and pH in more than 10 percent of visits. Timber Branch and Briery Swamps exceeded the DO standard in more than 10 percent of visits, but not the pH standard. Yorkers Swamp exceeded the pH standard in more than 10 percent of visits, but not the DO standard. Unnamed tributaries to Dragon Swamp XDO and XDX exceeded neither the DO nor pH standards in more than 10 percent of visits.

4. Water Quality Standard

According to Virginia Water Quality Standards (9 VAC 25-260-5), the term *"water quality standards means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."*

As stated above, Virginia water quality standards consist of a designated use or uses and a water quality criteria. These two parts of the applicable water quality standard are presented in the sections that follow.

4.1. Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10A), *"all state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish)."*

As stated above, Dragon Swamp must support all designated uses and meet all applicable criteria.

4.2. Applicable Water Quality Criteria

The applicable water quality criteria for DO and pH in the Dragon Swamp watershed are an instantaneous minimum DO of 4.0 mg/l and pH from 6.0 SU to 9.0 SU, as in Table 4.

Table 4. Applicable water quality standards

Parameter	Minimum, mg/l	Maximum, mg/l
DO	4.0	n/a
pH	6.0	9.0

If the waterbody exceeds the criterion listed above in more than 10.5 percent of samples, the waterbody is classified as impaired and natural conditions must be determined or a TMDL must be developed and implemented to bring the waterbody into compliance with the water quality criterion.

5. Assessment of Natural Conditions Affecting low DO - Process for determining if DO and pH impairments in free-flowing streams are due to natural conditions.

The level of dissolved oxygen in a water body is determined by a balance between oxygen-depleting processes (*e.g.*, decomposition and respiration) and oxygen-restoring processes (*e.g.*, aeration and photosynthesis). Certain natural conditions promote a situation where oxygen-restoring processes are not sufficient to overcome the oxygen- depleting processes. The level of pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity. Conditions in a stream that would typically be associated with naturally low DO and pH include slow-moving, ripple-less waters or wetlands where the decay of organic matter produces organic acids. These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems. The general approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below.

Step 1. Determine slope and appearance.
Step 2. Determine nutrient levels.
Step 3. Determine degree of seasonal fluctuation (for DO only).
Step 4. Determine anthropogenic impacts.

The results from this methodology (or process or approach) will be used to determine if the stream should be re-classified as Class VII Swamp Waters. Each step is described in detail below.

Procedure for Natural Condition Assessment of low pH and low DO in Virginia Streams

Prepared by Virginia Department of Environmental Quality
October 2004

I. INTRODUCTION

Virginia's list of impaired waters currently shows many waters as not supporting the aquatic life use due to exceedances of pH and/or DO criteria that are designed to protect aquatic life in Class III waters. However, there is reason to believe that most of these streams or stream segments have been mis-classified and should more appropriately be classified as Class VII, Swamp Waters. This document presents a procedure for assessing if natural conditions are the cause of the low pH and/or low DO levels in a given stream or stream segment.

The level of dissolved oxygen (DO) in a water body is determined by a balance between oxygen-depleting processes (*e.g.*, decomposition and respiration) and oxygen-restoring processes (*e.g.*, aeration and photosynthesis). Certain natural conditions promote a situation where oxygen-restoring processes are not sufficient to overcome the oxygen-depleting processes. The level of acidity as registered by pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity.

Conditions in a stream that would typically be associated with naturally low DO and/or naturally low pH include slow-moving, ripple-less waters. In such waters, the decay of organic matter depletes DO at a faster rate than it can be replenished and produces organic acids (tannins, humic and fulvic substances). These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems.

The general approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below. DEQ staff is proposing to use this approach to implement State Water Control Law 9 VAC 25-260-55, Implementation Procedure for Dissolved Oxygen Criteria in Waters Naturally Low in Dissolved Oxygen.

Waters that are shown to have naturally low DO and pH levels will be re-classified as Class VII, Swamp Waters, with the associated pH criterion of 4.3 to 9.0 SU. An associated DO criterion is currently being developed from swamp water data. A TMDL is not needed for these waters. An assessment category of 4C will be assigned until the waterbody has been re-classified.

II. NATURAL CONDITION ASSESSMENT

Following a description of the watershed (including geology, soils, climate, and land use), a description of the DO and/or pH water quality problem (including a data summary, time series and monthly data distributions), and a description of the water quality criteria that were the basis for the impairment determination, the available information should be evaluated in four steps.

Step 1. Determine appearance and flow/slope.

Streams or stream segments that have naturally low DO (< 4 mg/L) and low pH (< 6 SU) are characterized by very low slopes and low velocity flows (flat water with low reaeration rates). Decaying vegetation in such swampy waters provides large inputs of plant material that consumes oxygen as it decays. The decaying vegetation in a swamp water also produces acids and decreases pH. Plant materials contain polyphenols such as tannin and lignin. Polyphenols and partially degraded polyphenols build up in the form of tannic acids, humic acids, and fulvic acids that are highly colored. The trees of swamps have higher polyphenolic content than the soft-stemmed vegetation of marshes. Swamp streams (blackwater) are therefore more highly colored and more acidic than marsh streams.

Appearance and flow velocity (or slope if flow velocity is not available) must be identified for each stream or stream segment to be assessed for natural conditions and potential re-classification as a Class VII swamp water. This can be done through maps, photos, field measurements or other appropriate means.

Step 2. Determine nutrient levels.

Excessive nutrients can cause a decrease in DO in relatively slow moving systems, where aeration is low. High nutrient levels are an indication of anthropogenic inputs of nitrogen, phosphorus, and possibly organic matter. Nutrient input can stimulate plant growth, and the resulting die-off and decay of excessive plankton or macrophytes can decrease DO levels.

USGS (1999) estimated national background nutrient concentrations in streams and groundwater from undeveloped areas. Average nitrate background concentrations are less than 0.6 mg/L for streams, average total nitrogen (TN) background concentrations are less than 1.0 mg/L, and average background concentrations of total phosphorus (TP) are less than 0.1 mg/L.

Nutrient levels must be documented for each stream or stream segment to be assessed for natural conditions and potential re-classification as a Class VII swamp water. Streams with average concentrations of nutrients greater than the national background concentrations should be further evaluated for potential impacts from anthropogenic sources.

Step 3. Determine degree of seasonal fluctuation (for DO only).

Anthropogenic impacts on DO will likely disrupt the typical seasonal fluctuation seen in the DO concentrations of wetland streams. Seasonal analyses should be conducted for each potential Class VII stream or stream segment to verify that DO is depressed in the summer months and recovers during the winter, as would be expected in natural systems. A weak

seasonal pattern could indicate that human inputs from point or nonpoint sources are impacting the seasonal cycle.

Step 4. Determine anthropogenic impacts.

Every effort should be made to identify human impacts that could exacerbate the naturally low DO and/or pH. For example, point sources should be identified and DMR data analyzed to determine if there is any impact on the stream DO or pH concentrations. Land use analysis can also be a valuable tool for identifying potential human impacts.

Lastly, a discussion of acid rain impacts should be included for low pH waters. The format of this discussion can be based either on the process used for the recent Class VII classification of several streams in the Blackwater watershed of the Chowan Basin (letter from DEQ to EPA, 14 October 2003). An alternative is a prototype regional stream comparison developed for Fourmile Creek, White Oak Swamp, Matadequin Creek and Mechumps Creek (all east of the fall line). The example analysis under IV in this document, or the example report prepared for Fourmile Creek, illustrate this approach. For streams west of the fall line, a regional stream comparison for 2004 analyses encompasses Winticomack, Winterpock, and Chickahominy Rivers.

7Q10 Data Screen

If the data warrant it, a data screen should be performed to ensure that the impairment was identified based on valid data. All DO or pH data that violate water quality standards should be screened for flows less than the 7Q10. Data collected on days when flow was < 7Q10 should be eliminated from the data set and the violation rate recalculated accordingly. Only those waters with violation rates determined days with flows > or = 7Q10 flows should be classified as impaired.

In some cases, data were collected when flow was 0 cfs. If the 7Q10 is identified as 0 cfs as well, all data collected under 0 cfs flow would need to be considered in the water quality assessment. In those cases, the impairment should be classified as 4C, impaired due to natural conditions, no TMDL needed. However, a reclassification to Class VII may not always be appropriate.

III. NATURAL CONDITION CONCLUSION MATRIX

The following decision process should be applied for determining whether low pH and/or low DO values are due to natural conditions and justify a reclassification of a stream or stream segment as Class VII, Swamp Water.

If velocity is low or if slope is low (<0.50%) AND
If wetlands are present along stream reach AND
If no point sources or only point sources with minimal impact on DO and pH AND
If nutrients are < typical background

- ❖ average (= assessment period mean) nitrate less than 0.6 mg/L
- ❖ average total nitrogen (TN) less than 1.0 mg/L, and

- ❖ average total phosphorus (TP) are less than 0.1 mg/L AND

For DO: If seasonal fluctuation is normal AND
For pH: If nearby streams without wetlands meet pH criteria OR if no correlation between in-stream pH and rain pH,

THEN determine as impaired due to natural condition
→ assess as category 4C in next assessment
→ initiate WQS reclassification to Class VII Swamp Water
→ get credit under consent decree

The analysis must state the extent of the natural condition based on the criteria outlined above. A map showing land use, point sources, water quality stations and, if necessary, the delineated segment to be classified as swamp water should be included.

In cases where not all of these criteria apply, a case by case argument must be made based on the specific conditions in the watershed.

5.1 Preliminary Data Screen for Low Flow 7Q10

The 7Q10 flow of a stream is the lowest streamflow for seven consecutive days that occurs on average once every ten years. The first step for low flow 7Q10 screening is to determine the most accurate 7Q10 available. The 7Q10 flows for the Dragon Swamp tributaries may be estimated by a drainage area ratio of the 11 watersheds with the 7Q10 flow at the long-term continuous gauging station Dragon Swamp near Mascot, VA, (USGS: 01669520), with a drainage area of 109mi^2 and a 7Q10 of 0.12 cfs.

The DO Instantaneous Water Quality Standard applies **AT** 7Q10 flow, but **NOT** below 7Q10 flow (9 VAC 25-260-50 ***). Therefore in streams where the 7Q10 > 0.0 cfs, DO less than 4.0 mg/l taken at flows below 7Q10 are not water quality standard violations. However, in streams where the 7Q10 = 0.0 cfs, **ALL** DO data < 4.0 mg/l are standard violations, even if the flow = 0 cfs when the DO was taken.

One DO water quality standard violation at station 7-DRN003.40 was obtained at flows below 7Q10, therefore that sample was removed and the DO violation rate was recalculated to 10.8%.

5.2 Low slope, Swamps, Wetlands or Large Forested Areas

The slope of Dragon Swamp and 12 largest tributaries was determined. The low slope for these streams ranged from 0.07% to 0.29% (Table 5), which is less than the defined low slope criteria of 0.50%. Decomposition of the large inputs of decaying vegetation from areas of forested land with swamps and heavy tree canopy throughout the watersheds increase oxygen demand and lower DO as they decay, as well as contribute to the low pH by creation of natural weak organic acids (tannic, humic and fulvic acids) during decomposition of the decaying vegetation. These are not considered anthropogenic impacts. In table 5 the UT to Dragon Swamp with station (7-XAY001.64) the slope exceeds the criteria for low slope with a percent slope of 0.65% therefore this tributary is not a classified swampwater. Contrary Swamp was included in the report because the slope meets the criteria for swampwater and it contains areas of forested land with swamps and heavy tree canopy throughout the watershed like the other tributaries in the study. DEQ did not have a monitoring station on Contrary Swamp because it lacks public access.

Table 5. Calculated percent slope for the Dragon Swamp and Tributaries.

Stream	% Slope	Upstream Elevation (Feet) at Rivermile (RM)	Downstream Elevation (Feet) at Rivermile (RM)
Dragon Swamp	0.07	120’ at RM 33.80	10’ at RM 5.49
UT to Dragon (XAY001.64)	0.68	60’ at RM 1.71	10’ at RM 0.31
UT to Dragon (XDX000.38)	0.23	60’ at RM 2.08	40’ at RM 0.46
UT to Dragon (XDO001.77)	0.29	70’ at RM 2.23	40’ at RM 0.30
Briery Swamp	0.25	80’ at RM 3.81	40’ at RM 0.73
Timber Branch Swamp	0.19	90’ at RM 4.98	50’ at RM 0.90
Exol Swamp	0.12	120’ at RM 11.48	50’ at RM 0.23
Holmes Swamp	0.25	100’ at RM 3.89	60’ at RM 0.81
Yorkers Swamp	0.29	100’ at RM 3.37	60’ at RM 0.77
White Marsh	0.24	90’ at RM 2.34	70’ at RM 0.73
Dragon Run	0.15	130’ at RM 6.91	80’ at RM 0.50
Contrary Swamp	0.25	100’ at RM 1.77	80’ at RM 0.19

Visual inspections of Dragon Swamp and 11 tributaries revealed large swamp areas with heavy tree canopy. Decomposition of vegetative matter from large swampy areas lowers DO and pH as decay occurs. (Figures 40-61).

Figure 40. Dragon Run at Rt. 612, upstream.

Figure 41. Dragon Swamp at Rt. 612, upstream.

Figure 42. Dragon Run at Rt. 607, upstream.

Figure 43. White Marsh at Rt. 684, upstream.

Figure 44. Dragon Swamp at Rt. 604, upstream.

Figure 45. Exol Swamp at Rt. 614, upstream.

Figure 46. Timber Branch Swamp at Rt. 610, upstream.

Figure 47. Dragon Swamp at Rt. 602, upstream.

Figure 48. Briery Swamp at Rt. 606, upstream.

Figure 49. Dragon Swamp at Rt. 603, upstream.

Figure 50. Exol Swamp at Rt. 612, upstream.

5.3 Instream Nutrients

The VADEQ collected nutrient data from 7 stations, four located on Dragon Swamp and three on tributaries (April 1995 to March 2008, Tables 6-12). Data points below the limit of detection were averaged using half the detection limit. The average nutrient concentrations are below the USGS (1999) national background nutrient concentrations in streams from undeveloped areas levels of nitrate < 0.6 mg/l; TN (TKN + NO_3 + NO_2) < 1.0 mg/l; and TP < 0.1 mg/l. These low nutrient levels are not indicative of human impact.

Table 6. Instream Nutrients of Dragon Run at Rt. 607, 7-DGN000.85.

Parameter	Average Conc.	Number
Total Phosphorus	**0.095 mg/l**	(n=15)
Orthophosphorus	0.078 mg/l	(n=9)
Total Kjeldahl Nitrogen	0.789 mg/l	(n=9)
Ammonia as N	0.049 mg/l	(n=15)
Nitrate as N	**0.031 mg/l**	(n=9)
Nitrite as N	0.008 mg/l	(n=9)
TN (TKN + NO_3 + NO_2)	**0.699 mg/l**	(n=17)
Nitrite + Nitrate, Total as N	0.033 mg/l	(n=6)

Table 7. Instream Nutrients of Dragon Swamp at Rt. 603, 7-DRN010.48.

Parameter	Average Conc.	Number
Total Phosphorus	**0.065 mg/l**	(n=70)
Orthophosphorus	0.040 mg/l	(n=46)
Total Kjeldahl Nitrogen	0.446 mg/l	(n=60)
Ammonia as N	0.028 mg/l	(n=60)
Nitrate as N	**0.034 mg/l**	(n=43)
Nitrite as N	0.006 mg/l	(n=43)
TN (TKN + NO_3 + NO_2)	**0.560 mg/l**	(n=84)
Nitrite + Nitrate, Total as N	0.398 mg/l	(n=18)

Table 8. Instream Nutrients at Dragon Swamp at Rt. 602, 7-DRN015.51.

Parameter	Average Conc.	Number
Total Phosphorus	**0.080 mg/l**	(n=8)
Orthophosphorus	0.052 mg/l	(n=8)
Total Kjeldahl Nitrogen	0.738 mg/l	(n=8)
Ammonia as N	0.020 mg/l	(n=8)
Nitrate as N	**0.024 mg/l**	(n=8)
Nitrite as N	0.008 mg/l	(n=8)
TN (TKN + NO_3 + NO_2)	**0.769 mg/l**	(n=8)

Table 9. Instream Nutrients at Dragon Swamp at Rt. 604, 7-DRN024.19.

Parameter	Average Conc.	Number
Total Phosphorus	**0.094 mg/l**	(n=23)
Orthophosphorus	0.060 mg/l	(n=23)
Total Kjeldahl Nitrogen	0.687 mg/l	(n=23)
Ammonia as N	0.023 mg/l	(n=23)
Nitrate as N	**0.025 mg/l**	(n=23)
Nitrite as N	0.007 mg/l	(n=23)
TN (TKN + NO_3 + NO_2)	**0.718 mg/l**	(n=23)

Table 10. Instream Nutrients at Dragon Swamp at Rt. 612, 7-DRN030.75.

Parameter	Average Conc.	Number
Total Phosphorus	**0.064 mg/l**	(n=10)
Orthophosphorus	0.032 mg/l	(n=10)
Total Kjeldahl Nitrogen	0.720 mg/l	(n=10)
Ammonia as N	0.075 mg/l	(n=10)
Nitrate as N	**0.167 mg/l**	(n=10)
Nitrite as N	0.009 mg/l	(n=10)
TN (TKN + NO_3 + NO_2)	**0.896 mg/l**	(n=10)

Table 11. Instream Nutrients at Exol Swamp at Rt. 614, 7-EXE000.81.

Parameter	Average Conc.	Number
Total Phosphorus	**0.078 mg/l**	(n=23)
Orthophosphorus	0.048 mg/l	(n=12)
Total Kjeldahl Nitrogen	0.775 mg/l	(n=12)
Ammonia as N	0.030 mg/l	(n=23)
Nitrate as N	**0.022 mg/l**	(n=12)
Nitrite as N	0.008 mg/l	(n=12)
TN (TKN + NO_3 + NO_2)	**0.975 mg/l**	(n=23)
Nitrite + Nitrate, Total as N	0.468 mg/l	(n=11)

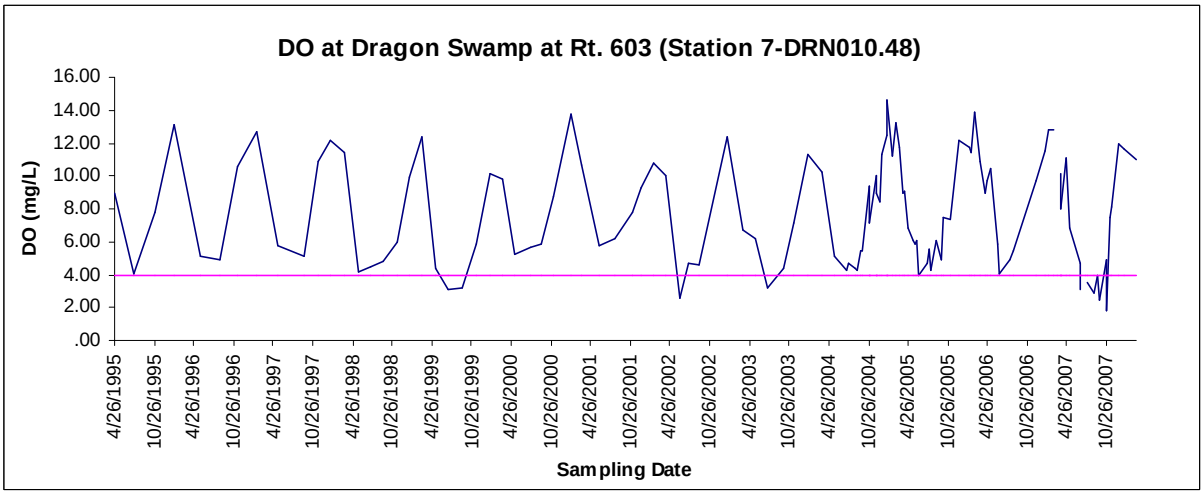
Table 12. Instream Nutrients at UT to Dragon Swamp at Rt. Piedmont Farm Rd, 7-XDO001.77.

Parameter	Average Conc.	Number
Total Phosphorus	**0.029 mg/l**	(n=12)
Orthophosphorus	0.012 mg/l	(n=12)
Total Kjeldahl Nitrogen	0.500 mg/l	(n=12)
Ammonia as N	0.069 mg/l	(n=12)
Nitrate as N	**0.151 mg/l**	(n=12)
Nitrite as N	0.008 mg/l	(n=12)
TN (TKN + NO_3 + NO_2)	**0.658 mg/l**	(n=12)

5.4 Natural Seasonal DO Fluctuation

The historical data collected at the Dragon Swamp was graphed to demonstrate the natural seasonal DO fluctuation due to the inverse relationship between water temperature and DO. DO is high in the winter months while water temperatures are low, and low in the summer months when water temperatures are high. This is depicted in Figure 77.

Figure 51. Seasonal Variation in DO at Dragon Swamp at Rt. 603, April 1995 through March 2008.



5.5 Impact from Point Source Dischargers and Land Use

There are 8 active permitted (2 VPDES; 2 VAG; 4 VAR) Point Source facilities in the Dragon Swamp and tributaries watersheds (C02R, and C03R). One VPDES permittee has a design flow and BOD5 permit limits, these are shown in Table 18. None of the facilities violated their permit limits for DO or pH during January 2003 to August 2008. The remaining VPDES permittee does not have a design flow, BOD5, TKN or DO limits. The Ingenco facility (VAG250115) is a cooling tower permit and only has a pH limit, Rappahannock Concrete (VAG110191) has to monitor for pH but does not have a limit. The rest of the facilities are industrial stormwater permits and do not monitor for Dissolved Oxygen or pH. These facilities are not expected to significantly impact DO or pH.

Table 13. Permitted dischargers with design flows and permit limits located within the Dragon Swamp tributaries watersheds.

Facility	Permit	Design Flow (MGD)	pH	DO (mg/L)	BOD (mg/L)	TKN (mg/L)	Receiving Stream
Rappahannock Community College-Glenns Campus	VA0028461	0.018	6-9	5.0	BOD5 max =25	N/A	UT to Dragon Swamp
Pitts Lumber Company Inc.	VA0083011	N/A	6-9	N/A	N/A	N/A	UT to Dragon Swamp
INGENCO-King and Queen	VAG250115	0.017	6-9	N/A	N/A	N/A	UT to Dragon Swamp
Rappahannock Concrete-Saluda	VAG110191	N/A	No Limit	N/A	N/A	N/A	UT to Dragon Swamp
BFI King and Queen Landfill	VAR050621	N/A	N/A	N/A	N/A	N/A	UT to Dragon Swamp
William H. Milby Lumber Company	VAR050659	N/A	N/A	N/A	N/A	N/A	UT to Dragon Run
Carlton and Edwards Lumber	VAR050911	N/A	N/A	N/A	N/A	N/A	UT to Dragon Swamp
Fishers Imported Auto Salvage Inc.	VAR051213	N/A	N/A	N/A	N/A	N/A	Dragon Run
Millers Square Subdivision WTP Terminated on 5/7/2008	VA0075302	.00075	6-9	N/A	N/A	N/A	UT to Dragon Run
Union Hope Baptist Church	VAR102555	Storm water construction permit					UT to Dragon Swamp

Urban areas compose approximately 0.2 percent of the land base, an insignificant portion of the watershed. Agriculture makes up approximately 18.8 % of the watershed. The watershed is predominately forested (71.4 percent), with 8.3 percent wetlands and 0.3 open water. Land use was not considered to have significantly impacted the swampwater conditions of the Dragon Swamp and tributaries.

6. CONCLUSION

The following decision process is proposed for determining whether low DO values are due to natural conditions:

If slope is low (<0.50) AND
If wetlands or large areas of forested land are present along stream reach AND
If no point sources or point sources with minimal impact on DO AND
If nutrients are < typical background

- average (= assessment period mean) nitrate less than 0.6 mg/L
- average total nitrogen (TN) less than 1.0 mg/L, and
- average total phosphorus (TP) are equal to or less than 0.1 mg/L AND

If nearby streams without wetlands meet DO criteria,

THEN determine as impaired due to natural condition
→ assess as category 4C in next assessment
→ initiate WQS reclassification to Class VII Swamp Water
→ get credit under consent decree

There was one DO water quality standard violation that was obtained at flows below 7Q10, therefore that sample was removed from the dataset and the statistics were recalculated at station 7-DRN003.40. The recalculated DO violation rate was at 10.81%.

The slopes were determined for Dragon Swamp and 11 tributaries. The low slope for these streams ranged from 0.07% to 0.29%, which was considered very low to low slope. Decomposition of the large inputs of decaying vegetation from areas of forested land with swamps and heavy tree canopy throughout the watershed increase oxygen demand, lower DO, result in production of weak organic acids, and lower pH as they decay. These are not considered anthropogenic impacts.

The Dragon Swamp tributaries exhibit low nutrient concentrations below national background levels in streams from undeveloped areas, which are not indicative of human impact.

The Dragon Swamp tributaries exhibit natural seasonal DO fluctuation due to the inverse relationship between water temperature and DO.

There are 8 active permitted (2 VPDES; 2 VAG; 4 VAR) Point Source facilities in the Dragon Swamp tributaries watersheds (C02R, and C03R). One VPDES permittee has a design flow and BOD5 permit limits, these are shown in Table 18. None of the facilities violated their permit limits for DO or pH during January 2003 to August 2008. The remaining VPDES permittee does not have a design flow, BOD5, TKN or DO limits. The Ingenco facility (VAG250115) is a cooling tower permit and only has a pH limit, Rappahannock Concrete (VAG110191) has to monitor for pH but does not have a limit. The rest of the facilities are industrial stormwater permits and do not monitor for Dissolved Oxygen or pH. These facilities are not expected to significantly impact DO or pH.

Residential and high use industrial areas compose approximately 0.2 percent of the land base, an insignificant portion of the watershed. Agriculture makes up approximately 18.8 % of the watershed. The watershed is predominately forested (71.4 percent), with 8.3 percent wetlands and 0.3 open water. Land use was not considered to have significantly impacted the swampwater conditions of the Dragon Swamp and tributaries.

Based on the above information, a change in the water quality standards classification to Class VII Swampwater due to natural conditions, rather than a TMDL, is indicated for Dragon Swamp and tributaries located in waterbodies identification codes (WBID, Virginia Hydrologic Unit) C02R, C03R, and C03E, a total of 178.62 non-tidal rivermiles and 1.11 tidal square miles. The specific waterbodies are listed below in Table 19. If there is a 305(b)/303(d) assessment prior to the reclassification, Dragon Swamp and these tributaries will be assessed as Category 4C, Impaired due to natural condition, no TMDL needed.

Unnamed tributaries to Dragon Swamp XDO and XDX were not proposed for Class VII designation because their water quality data exceeded neither the DO nor pH water quality standards in more than 10 percent of samples. Unnamed tributary to Dragon Swamp XAY was not proposed for Class VII designation because the slope (0.65%) exceeded the recommended Class VII slope threshold of 0.50%, and the monitoring station was located in the intermittent upstream portion of the tributary. Contrary Swamp was included in the Class VII proposal because its slope (0.25%) was well below the upper slope threshold of 0.50% for Class VII and it contains areas of forested land with swamps and heavy tree canopy throughout the watershed, even though DEQ had no data collected on the swamp because of no public access. DEQ staff selected perennial headwaters as the upstream boundaries of the proposed Class VII segments because above the perennial portions of the waterbodies, flow was intermittent and slopes frequently exceeded the 0.50% upper Class VII threshold. Staff determined perennial stream miles from the USGS National Hydrography Dataset using GIS.

Table 14. Class VII Swampwater designations for the Dragon Swamp and Tributaries.

Stream	Miles	Upstream Class VII Boundary	Downstream Class VII Boundary
Briery Swamp and tributaries	3.93	Perennial Headwaters	Confluence with Dragon Swamp
Timber Branch Sw and tributaries	8.74	Perennial Headwaters	Confluence with Dragon Swamp
Exol Swamp and tributaries	25.37	Perennial Headwaters	Confluence with Dragon Swamp
Holmes Swamp and tributaries	8.74	Perennial Headwaters	Confluence with Exol Swamp
Yorkers Swamp and tributaries	4.28	Perennial Headwaters	Confluence with Dragon Swamp
White Marsh and tributaries	2.56	Perennial Headwaters	Confluence with Dragon Swamp
Contrary Swamp	2.02	Perennial Headwaters	Confluence with Dragon Swamp
Dragon Run and tributaries	13.18	Perennial Headwaters	Confluence with Dragon Swamp
Dragon Swamp and tributaries to RM 4.60	109.80	Perennial Headwaters	Head of Tide at River Mile 4.60
Dragon Swamp Tidal	1.11mi^2	Head of Tide at River Mile 4.60	Confluence with Piankatank River

DEQ performed the assessment of the Dragon Swamp tributaries low DO and low pH natural condition in lieu of a TMDL. Therefore neither a TMDL Technical Advisory Committee (TAC) meeting nor a public meeting was involved. Public participation will occur during the next water quality standards triennial review process.

7. References

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